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A PRESSURE SEWER SYSTEM DEMONSTRATION

Italo G. Carcich, et al

Environmental Protection Agency
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A PRESSURE SEWER SYSTEM DEMONSTRATION

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16. Abstract

A field demonstration of 12 Grinder Pump (GP) Units was performed for a 18 month period in Albany, New York.

Continuous operational records were kept by means of an automatic monitoring system. Pressures, water usage, operating time, overflow occurrences, total number of operations simultaneous operations were recorded for the duration of the project.

The prototype GP Units registered an undesirably high number of malfunctions: loss of prime by pump, and grease clogging of pressure sensing tube. The new modified GP Units performed exceedingly well for the last 7 months of the demonstration and were not afflicted by the aforementioned incidents. There was no visible wear and tear of the mechanical components of the units.

The effectiveness of small, non-metallic pipes transporting the macerated wastewater under pressure was successfully demonstrated. Grease accumulation did occur and all of the results are pointing to a need for a careful hydraulic design.

Extensive chemical sampling proved that the pressure sewer waste was 100% stronger but contained 50% less contaminants on a gm/capita/day basis. Settleability tests on the pressure sewer waste showed no significant differences over conventional wastewater.

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A PRESSURE SEWER SYSTEM DEMONSTRATION

By

Italo G. Carcich
Leo J. Hetling
R. Paul Farrell

Project 11022 DQI

Project Officer

Richard Keppler
EPA - Region I
John F. Kennedy Bldg.
Boston, Massachusetts 02203

Prepared for

OFFICE OF RESEARCH AND MONITORING
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ABSTRACT

A field demonstration of 12 Grinder Pump (GP) Units was performed for a 13 month period in Albany, New York.

Continuous operational records were kept by means of an automatic monitoring system. Pressures, water usage, operating time, overflow occurrences, total number of operations, simultaneous operations were recorded for the duration of the project.

The prototype GP Units registered an undesirably high number of malfunctions; loss of prime by pump, and grease clogging of pressure sensing tube. The new modified GP Units performed exceedingly well for the last 7 months of the demonstration and were not afflicted by the aforementioned incidents. There was no visible wear and tear of the mechanical components of the units.

The effectiveness of small, non-metallic pipes transporting the macerated wastewater under pressure was successfully demonstrated. Grease accumulation did occur and all of the results are pointing to a need for a careful hydraulic design.

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SECTION I

CONCLUSIONS

1. The project site provided representative test conditions in regard to number of occupants, appliance loadings, water usage, etc.

2. The pressure sewer system including PVC Schedule 40 Pipes and PVC-DWV fitting functioned extremely well.

3. The automatic monitoring system did its job very well, producing voluminous but pertinent data, reliably. Pressure gaging was not entirely dependable but was within 85-90% of the computed values.

4. Functional specifications of household Grinder Pumps (GP) were proven to be appropriate.

5. The prototypes exhibited mechanical reliability too low to be of practical use (27 malfunctions for the first six months).

6. All major malfunctions were eliminated in the modified GP Unit, such as, increasing the opening of the pressure sensing tube from 1" to 3" and having the pump positively primed. The Modified GP Unit was installed early enough in the demonstration project to obtain 7½ months of operating experience.

7. The necessity for pumps with a vertical H-Q curve, positively primed and protected against siphoning, was adequately demonstrated for use in any system application.

8. A very low service call rate for the modified GP Units, coupled with "down-time" performance of 0.27% in comparison to 2.69% for the prototype GP Units, indicated the mechanical reliability of these units in the pressure sewer system concept.

9. During this demonstration period (over 13 months) in a group of 12 town houses, there was a total of 79,740 Grinder Pump Unit operations, for an average of 2.6 operations/capita/day. Average length of operating cycle was in the range of 57 to 74 seconds. Watt-hour meters indicated the operating cost for electric power was only 34¢/capita/year.

10. Although no seasonal variations in use pattern were shown, flows varied widely during different times of day, and from house to house. The average wastewater flow for the 12 town houses was 32 gallons/capita/day.

11. Pump size and tank volume were more than adequate to handle peak wastewater flows, so that no further design modifications are necessary in this area.

12. The hydraulic characteristics of a pressure sewer system are critical. Careful design of pressure mains and laterals will prevent excessive grease accumulations, as experienced in this demonstration project, and produce a much more economical system. Grease accumulations were extensive in certain lengths of the pressure main, primarily due to oversizing. The minimum scouring velocities, as recommended by the ASCE task force, were not high enough to prevent grease from accumulating. Velocities in the range of 2 fps to 5 fps might have prevented grease accumulation from occurring.

13. Chemical analysis of the pressure sewer wastewater showed that even though it had been pre-ground, there was no significant difference in settleability.

14. Because of elimination of infiltration, the average concentration of pollutants in the pressure sewer wastewater was 100% greater than in conventional systems. This "stronger" sewage would tend to be more amenable to treatment by most existing methods. The per capita contributions of pollutants was about 50% less than average conventional values. This can perhaps be accounted for by the fact that the population of the demonstration project contained a much higher proportion of children to adults than the New York State average.

SECTION II

RECOMMENDATIONS

An extensive accumulation of data on pressure sewers and the Grinder Pump (GP) Unit has been presented and summarized in this report. The mechanical reliability of the GP Unit and the nature of pressure sewer systems have been established and necessary engineering design parameter documented. Because of this, there appears to be no need for further demonstration, and it is recommended that pressure sewer systems be considered as available engineering technology for use where applicable.

The hydraulic design is a very critical facet of any new pressure sewer system. Some grease accumulation can be expected in any domestic pressure sewer system because of the nature of the waste and long periods of non-usage. However, critical hydraulic design will limit any excessive grease accumulation and at the same time, will offer the most economical system to the customer.

It is recommended that the swing check valve be relocated from its present position in the modified GP Units to a more favorable location followed by a horizontal section of pipe of no less than 12" in length. This will prevent any solids from settling near the discharge opening of swing check valve assembly.

Commercially available shut-off valves should be installed immediately downstream on the discharge pipe in order that the GP Unit can be isolated from the pressure system for maintenance and repair work. Likewise, since the pressure system is, in many respects, similar to a water distribution system, air relief valves should be installed in the system whenever necessary.

Extensive power failures are not very common throughout the country. However, in certain small areas of the U.S. due to weather conditions and other uncontrollable factors, power failures are more frequent. Therefore, when designing a pressure sewer system, a power failure should be a minor consideration. It should be noted that under normal operating conditions, the GP Units tank affords 8 to 12 hours of wastewater storage, which is sufficient to accommodate short duration power failures.

It has been maintained from the start that the GP Units and the pressure sewer system concept were not meant to replace the conventional (gravity fed) wastewater collection system. Instead, GP Units are meant to be a supplemental tool in any wastewater collection system. The economics of the pressure system versus the gravity system for a particular area of the country or even for a specific section within a collection system will dictate the usage of the GP Units.

Therefore, it will depend on the consulting engineer to determine the specific cut off point in the economic analysis which will favor the pressure sewer system installation versus the gravity system.

SECTION III

INTRODUCTION

"To meet the general requirements of sanitation, wastewater disposal systems must perform two functions: (1) reliable and inoffensive collection of waste matters from households and industry; and (2) safe disposal of the water-carried wastes into water or, less commonly, onto land"(1). There have been over the past century many significant advances in technology and practice relating to the second function but little relating to the first. This in spite of the fact that the above quote from one of the classical environmental engineering texts gives equal importance to each and that a quick check on the cost of any waste disposal system shows that the major costs are related, not to treatment, but to collection.

Because of the above lack of innovation, present methods for conveying sewage have not changed appreciably from the system used by the Romans two thousand years ago to transport water; i.e., the aqueduct.

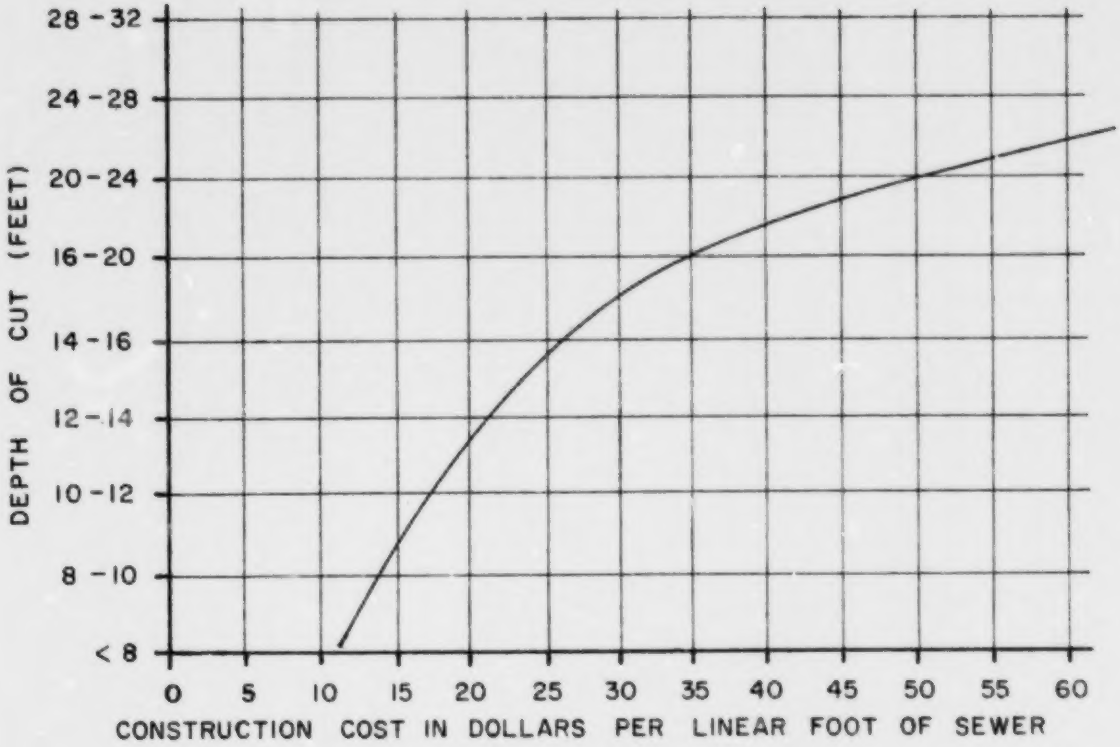
The only difference between an aqueduct and the present day gravity sewer is that one is above grade and the other is below. The prime mover in both systems is gravity. Certainly, this is a satisfactory method for many situations since it involves few working parts and a source of power less expensive than gravity has not been found. However, in certain situations, such as excessively hilly terrain, high ground water, rock, or where sewers become quite deep, there are definite economic disadvantages. For example, Figure 1 shows the relationship between cost and depth for a typical eight inch vitrified clay gravity sewer. The curve is non-linear and, for depths above twelve feet, the cost per foot increases sharply, reflecting the added cost of construction practices necessary at these depths, such as sheeting, bracing and dewatering. Overall, the curve for an eight inch gravity sewer shows that, for a four-fold increase in depth, the cost per foot increases by a factor of seven.

Historical Development

The late Dr. Gordon M. Fair, realizing the above and attempting to arrive at a solution to the combined sewer overflow problem conceived and actively pursued a concept which ultimately led to this project. Dr. Fair's idea was to solve the combined sewer overflow problem by superimposing a pressure sewer system within the combined sewers existing in most American cities. By utilizing the pressure system for conveying sanitary sewage, the existing combined sewers would become storm sewers and thus a separation could be effected. At his urging and with the support of a Federal Water Pollution Control Administration grant contract (14-12-29) the American Society of Civil Engineers (ASCE) initiated an investigation of the feasibility of Professor Fair's concept. Considering the fact that in northern United States over 3%(2) of the total annual sewage volume is

FIGURE I

8" VITRIFIED CLAY PIPE SEWER CONSTRUCTION COSTS*



*E.N.R. Construction Index – June 1972

diverted directly to receiving streams, rivers and lakes during high runoff flows with an additional heavy solids contribution scoured from sewer systems and street pavements, economical separation processes were, therefore, deemed essential for this country.

The total ASCE Research Plan as shown in Figure 2 was a comprehensive one and included simultaneous investigations of many facets of the total question.

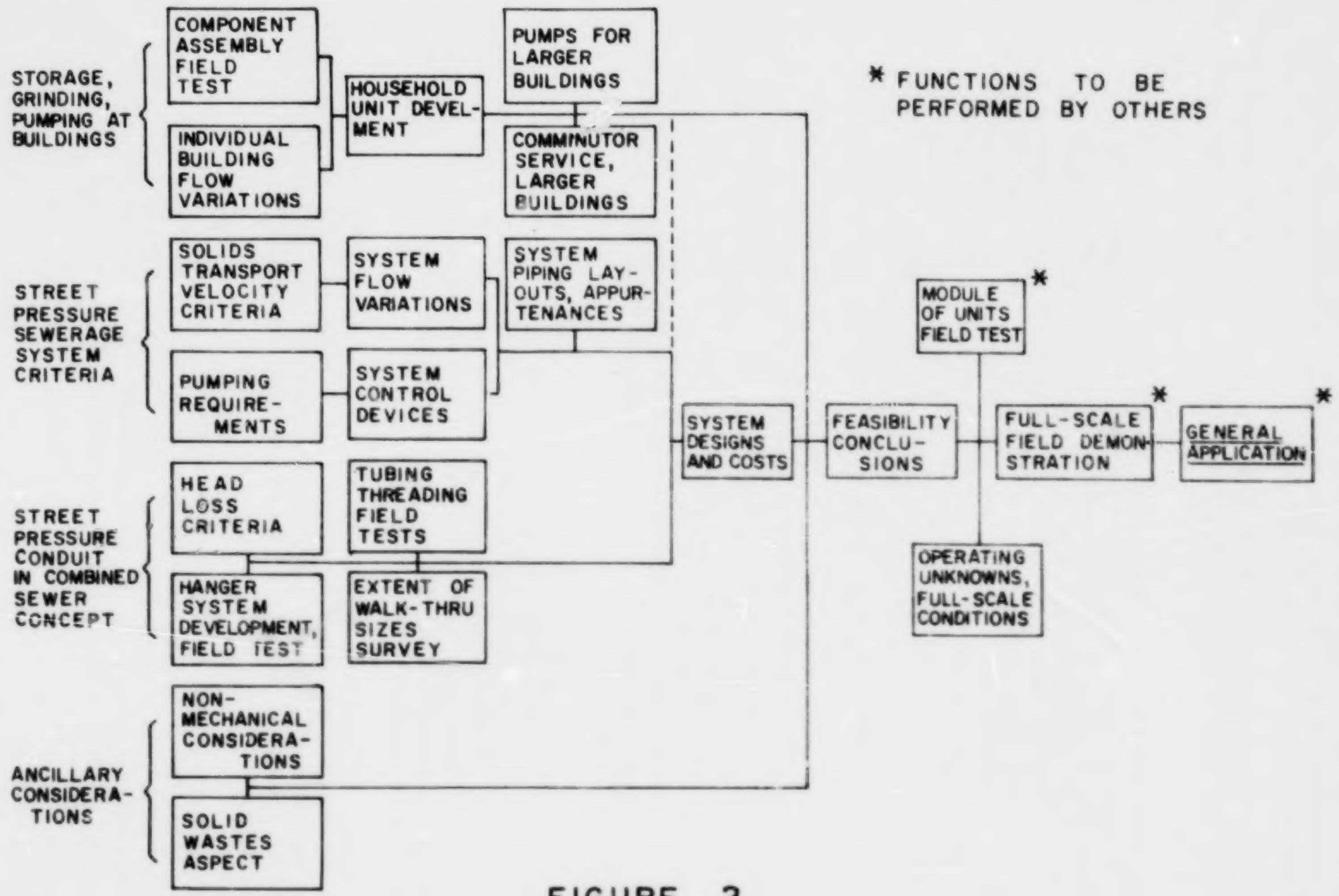
The preliminary results of the ASCE study were generally unfavorable for the insertion of a pressurized sewer within existing combined sewers. The installation of the pressurized sewer in a walk-through sewer was relatively simple to accomplish, but, the installation in a non walk-through sewer was much more difficult(3). The difficulty was compounded by a survey of the major metropolitan areas in the United States indicating that 85% of all the combined sewers have an inside diameter of 48 inches or less, and, on the average, 72% of all combined sewers have an inside diameter of 24 inches or less(4). The insertion of polyethylene pipe, which could be pushed or pulled a reasonable length(5) within the smaller combined sewers, could possibly create clogging problems and reduce by as much as 12% the maximum carrying capacity of these same combined sewers.

Even though a pressurized sewer would, in reality, increase the capacity of wastewater treatment facilities by eliminating storm waters and ground water infiltration, the ASCE project indicated that Dr. Fair's concept is not economically feasible for most cities in the United States. Results of the investigation of three areas; a commercial site in Boston(6), and two residential sites; one in Milwaukee(7) and the other in San Francisco(8), showed that the separation process utilizing pressure sewers would be more expensive than the conventional method of installing a second gravity system.

At the same time, a concurrent number of studies were being carried out in order to evaluate the entire separation process from its inception within a residential or commercial building to its termination point, which happens to be either a wastewater treatment facility or a receiving body of water. Researchers were establishing relationships between wastewater flows and water usages, while others were laboratory testing minimum transport velocities within small pipes.

Under the original separation concept, the large commercial and residential buildings would be served by lift stations equipped with commercially available wastewater pumps and comminutors. However, the availability of a small pumping unit capable of serving individual households had to be investigated.

The General Electric Company subcontracted by the ASCE project staff developed a household storage-grinder-pump unit(9). It was concluded, however, that the new tool was much more practical for other usages rather than its application in separating combined sewers. Near the end of this ASCE project, a full-scale field demonstration was planned in-



STORAGE, GRINDING, PUMPING AT BUILDINGS
COMPONENT ASSEMBLY FIELD TEST
INDIVIDUAL BUILDING FLOW VARIATIONS
HOUSEHOLD UNIT DEVELMENT
PUMPS FOR LARGER BUILDINGS
COMMINUTOR SERVICE, LARGER BUILDINGS
STREET PRESSURE SEWERAGE SYSTEM CRITERIA
SOLIDS TRANSPORT VELOCITY CRITERIA
PUMPING REQUIRE- MENTS
SYSTEM FLOW VARIATIONS
SYSTEM CONTROL DEVICES
SYSTEM PIPING LAY- OUTS, APPUR- TENANCES
STREET PRESSURE CONDUIT IN COMBINED SEWER CONCEPT
HEAD LOSS CRITERIA
HANGER SYSTEM DEVELOPMENT, FIELD TEST
TUBING THREADING FIELD TESTS
EXTENT OF WALK-THRU SIZES SURVEY
ANCILLARY CONSIDERA- TIONS
NON- MECHANICAL CONSIDERA- TIONS
SOLID WASTES ASPECT
SYSTEM DESIGNS AND COSTS
FEASIBILITY CONCLU- SIONS
MODULE OF UNITS FIELD TEST *
OPERATING UNKNOWNS, FULL-SCALE CONDITIONS
FULL-SCALE FIELD DEMON- STRATION *
GENERAL APPLICATION *
* FUNCTIONS TO BE PERFORMED BY OTHERS

FIGURE 2

PRESSURE SEWERAGE RESEARCH PLAN FOR ASCE COMBINED SEWER SEPARATION PROJECT corporating the storage-grinder-pump units in a pressurized independent sewer serving a number of private residences.

Although most of the ASCE project's objectives were accomplished, it was unfortunate that, because of over-runs in time and money, it was not possible for ASCE to carry out the originally planned field demonstration.

Previous to this project's inception, Mortimer A. Clift successfully applied the concept of pressure sewers to a section of Radcliff, Kentucky. According to Mr. Clift, a combination of unusual conditions including topography, rapid growth and dispersion of residential development justified using such a system and it was installed in 1964. Clift's experience with the design and operation of this system, which serves forty-two houses, was published in 1968(10).

Potential Applications

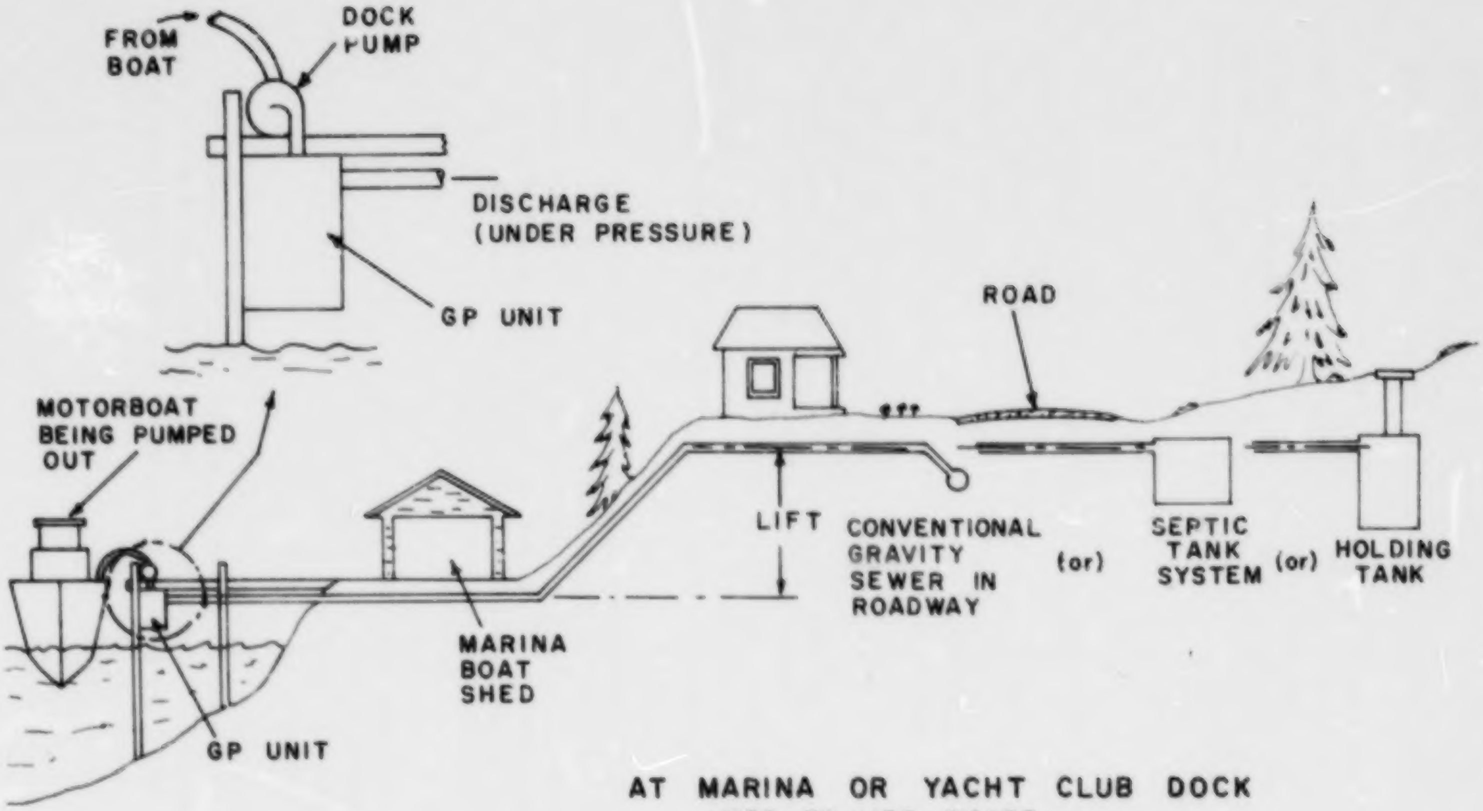
Since the utilization of the storage-grinder-pump unit for separating combined sewers was found to be unfeasible, its applications as visualized for the use in pressure sewer systems, are illustrated in the accompanying figures. Figure 3 shows a pressure system lifting the waste from a motor boat pump-out station to a suitable disposal plant at a higher elevation, which might be a gravity sewer, a septic system, or even a holding tank.

Bringing service to a house with fixtures below the grade of the gravity sewer is pictured in Figure 4. This might involve the remodeling of an existing house or it might be done to serve a house that had originally been on a septic tank and, when a new sewer district was created, the house drain was too high to be reached by gravity. It might be done in a few houses in designing a new sewer district in order to keep the entire gravity system at a shallower elevation and, therefore, less expensive throughout.

Entire neighborhoods might be served by pumping into an existing gravity sewer at a higher elevation. In the example shown in Figure 5, a neighborhood which was originally equipped with septic tanks which are beginning to fail, has been connected together into a system which pumps into an adjacent street. Obviously, the sewer in the adjacent street must have the necessary capacity and the treatment plant that it leads to must be able to handle the load.

Sometimes, right on the same lot, it may be necessary to go to higher elevations to find suitable soil for subsurface disposal systems, if percolation is not suitable in those parts of the land that can be reached by gravity (Figure 6).

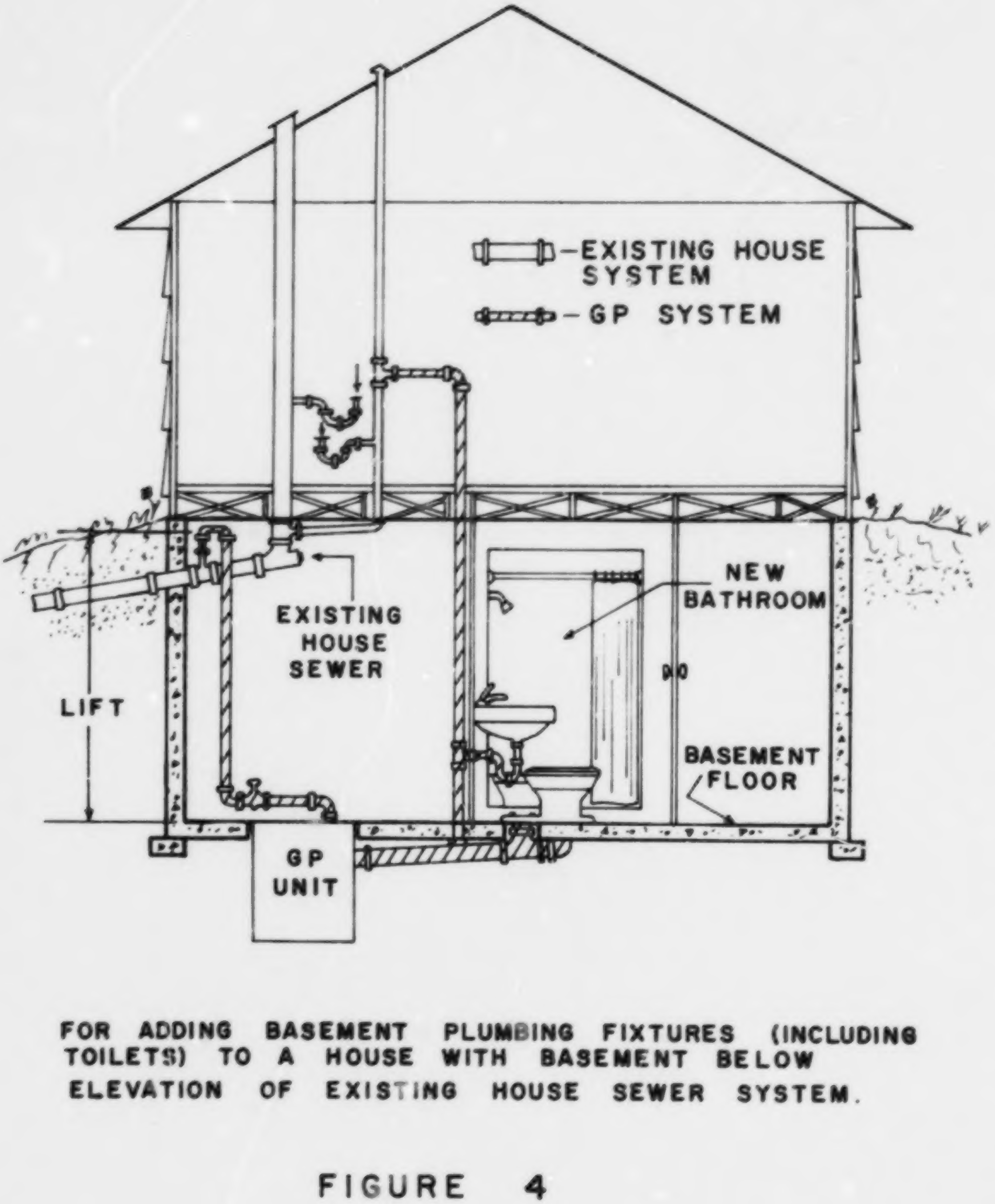
Another very exciting possibility is in serving lakeside and waterfront properties as shown in Figure 7. In these situations, the only way to go by gravity is toward the waterfront. Pressure sewers can be run uphill to avoid tearing up the waterfront and to protect the lake from pollution.


FROM BOAT
DOCK PUMP
DISCHARGE (UNDER PRESSURE)
GP UNIT
ROAD
MOTORBOAT BEING PUMPED OUT
LIFT
CONVENTIONAL GRAVITY SEWER IN ROADWAY
(or)
SEPTIC TANK SYSTEM
(or)
HOLDING TANK
MARINA BOAT SHED
GP UNIT

AT MARINA OR YACHT CLUB DOCK

USED TO LIFT WASTE FROM PUMP-OUT STATION ON DOCK TO DISPOSAL LOCATION AT HIGHER ELEVATION

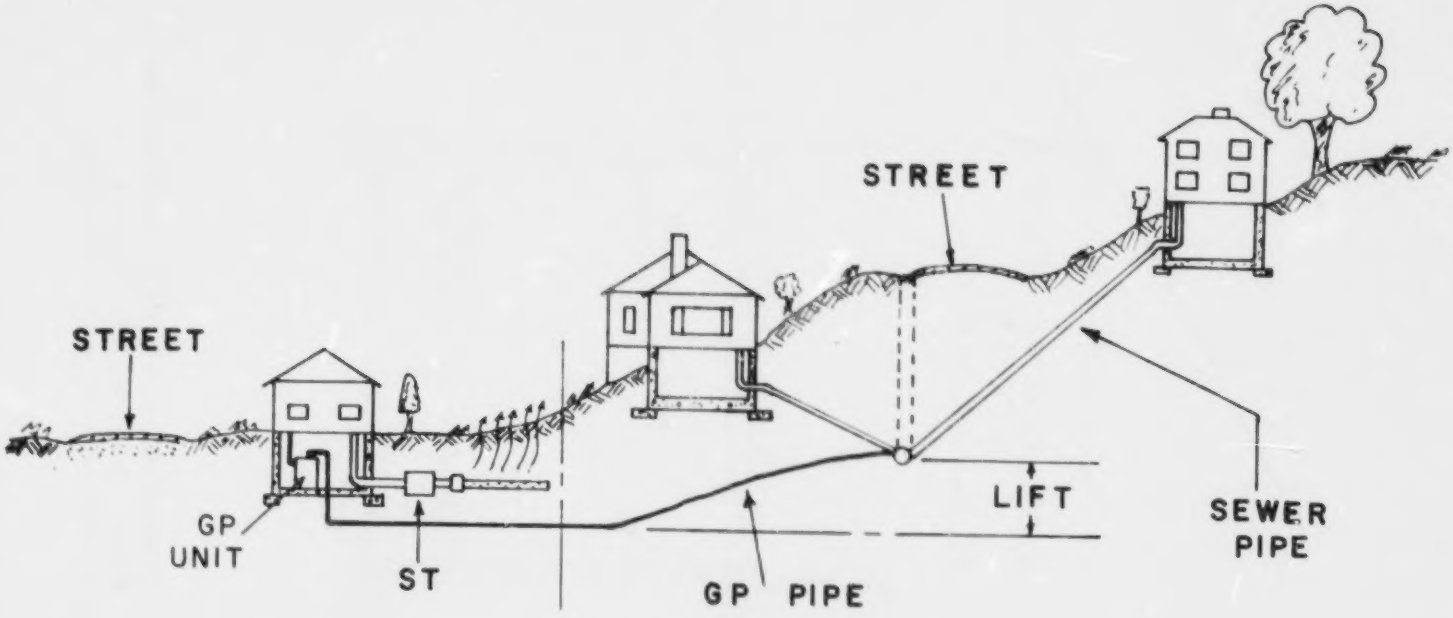
FIGURE 3



—EXISTING HOUSE SYSTEM
—GP SYSTEM
EXISTING HOUSE SEWER
NEW BATHROOM
LIFT
BASEMENT FLOOR
GP UNIT

FOR ADDING BASEMENT PLUMBING FIXTURES (INCLUDING TOILETS) TO A HOUSE WITH BASEMENT BELOW ELEVATION OF EXISTING HOUSE SEWER SYSTEM.

FIGURE 4


STREET
STREET
GP UNIT
ST
GP PIPE
LIFT
SEWER PIPE

UNSEWERED STREET

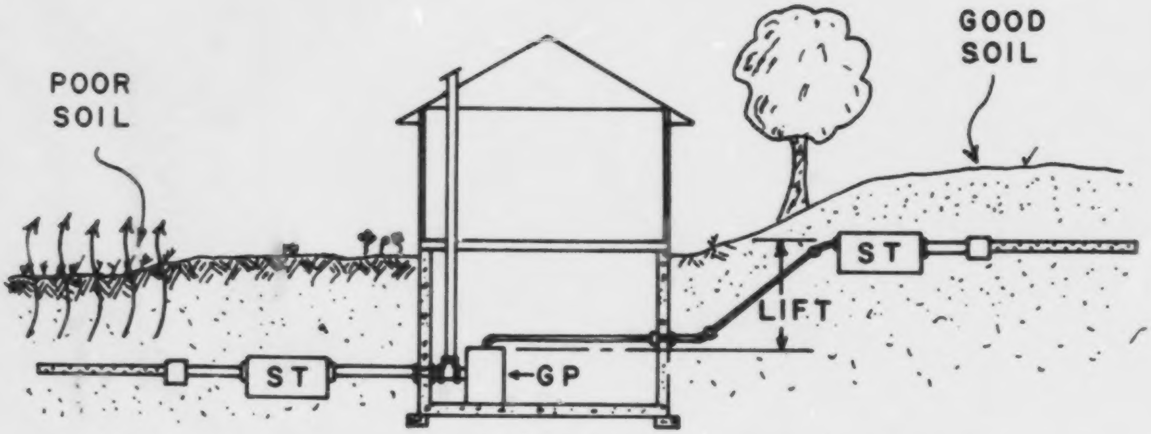
WITH SEPTICTANK FAILURES, BUT TOO LOW TO RUN BY GRAVITY INTO SEWERS IN ADJACENT UPHILL STREET

(ALSO TO DEVELOP OTHERWISE-UNSUITABLE LAND)

SEWERED STREET

WITH SOME EXCESS CAPACITY IN SEWERS AND TREATMENT PLANT

FIGURE 5



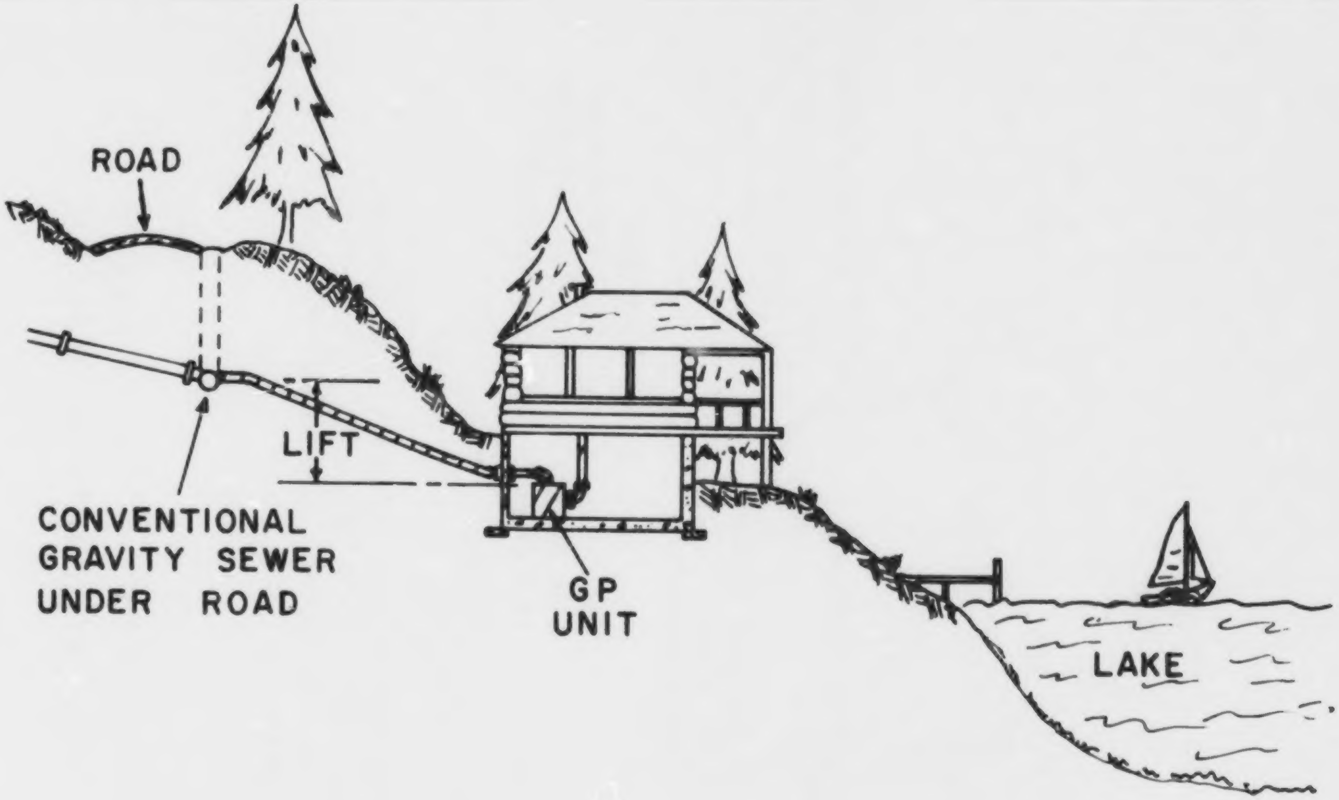
OLD SYSTEM
FAILING ABSORPTION FIELD ON LOW GROUND WITH UNSUITABLE SOIL CONDITIONS.

NEW SYSTEM
CAN BE INSTALLED ANYWHERE ON PROPERTY WHICH AFFORDS SUITABLE SOIL CONDITIONS.

NOTE: OK FOR SITUATIONS WITH PUBLIC WATER SUPPLY, BUT WITH WELL ON LOT PRECAUTIONS TO AVOID CONTAMINATION MUST BE TAKEN.

HOUSE ON LARGE LOTS WITH FAILING SEPTICTANK SOIL ABSORPTION SYSTEM

FIGURE 6


ROAD
LIFT
CONVENTIONAL GRAVITY SEWER UNDER ROAD
GP UNIT
LAKE

LAKE FRONT PROPERTY

VACATION OR YEAR ROUND OCCUPANCY
(GRAVITY SEWER AVAILABLE BUT AT
HIGHER ELEVATION THAN HOUSE)

FIGURE 7

Recognizing the potential of the pressure sewer concept and the need for and value of a demonstration to the people of New York, the New York State Department of Environmental Conservation's Research and Development Unit assumed the responsibility for sponsoring and carrying out such a field demonstration. Because of its potential nation-wide application, partial support for the project was sought and received from the Environmental Protection Agency as part of its Storm and Combined Sewer Pollution Control Program.

(16 blank)

SECTION IV

DESCRIPTION OF INSTALLATION AND OPERATION OF DEMONSTRATION PROJECT

Introduction

The Pressure Sewer System Demonstration Project concerned itself with five (5) major objectives(11). The final evaluation of these objectives was substantially dependent on the selection of a project site suitable for the temporary installation of a pressure sewer system and automatic monitoring equipment designed to record essential parameters at a predetermined time interval.

Selection of Project Site

There were many sites investigated before the final selection was made. Table 1 summarizes each of these sites according to its location, number of houses, type of development, etc.

The sites were reviewed based on the following criteria(11),

1. The location was to be close enough to the Albany-Schenectady-Troy area that the Environmental Conservation Department personnel could design a system to match the site and could readily monitor the project throughout its total duration.

2. An area where the combined sewer approach was still in use.

3. The site was to be such that the owner or potential owner's lot could be excavated to install a gravity sewer at which time the pressure sewer system could also be installed.

4. The configuration of the site was to be such that twelve houses already in place or to be constructed to be used in the demonstration were located adjacent, one to the other, or equal numbers on either side of the street, so that twelve of these could ultimately be connected into a common pressure system.

In the demonstration grant application, the Lark Street Development was tentatively chosen on the condition that, at least twelve town houses would be under construction by the summer of 1969. Due to financial difficulties, this development did not materialize and, during the summer of 1969, the alternate sites were again reviewed and a search for new sites was initiated.

The South Pearl Street Development was the only new site located and proved to be the most feasible of the available sites for the Demonstration Project.

TABLE 1 - POSSIBLE SITES FOR THE PRESSURE SEWER SYSTEM DEMONSTRATION PROJECT

NAME	LOCATION	NO. OF SITES	TYPE OF SEWER SERVICE	TYPE OF DEVELOPMENT
Williamsburg	Town of Guilderland County of Albany	30	Sanitary Sewers as part of a Community Septic System	1 Family Houses ¼ acre or more of land Middle Income
Karlsfeld District	City of Albany County of Albany	10	City Sewers	1 Family Houses ½ acre or more of land Middle to High Income
Miami Beach Estates (Hialeah Drive)	City of Troy County of Rennselaer	34	Sanitary City Sewers	1 Family Houses ¼ acre or more of land Middle Income
Pleasantdale Estates	Town of Schaghticoke County of Rennselaer	34	Expected Sanitary City Sewers	1 Family Houses ¼ acre or more of land
Lark Street Development	City of Albany County of Albany	24	City Sewers	Town Houses or Row Houses Middle Income
South Pearl Street Development	City of Albany County of Albany	23	City Sewers	Town Houses or Row Houses Low Income

Location of Site

The site was located in the southeastern part of the City of Albany near the Port of Albany (Figure 8) approximately 3/4 of a mile west of the Hudson River. The land was donated by a religious organization to the Inter-Faith Better Homes Development Corporation of Albany for the sole purpose of erecting low income housing.

Description of Project Site

The site and the surrounding low-lying areas were filled in by the City of Albany some time ago with the present average elevation of the site approximately twenty feet above mean sea level.

According to the conditions stipulated in the grant application, twelve town houses were selected in order to test the prototype GP Units. Figure 9 shows the entire Inter-Faith Better Homes Development Corporation and specifically the twelve houses that were chosen for the demonstration project.

The development is served by city water and sewers and by the Niagara Mohawk Power Corporation for electric power and gas service. It is a combined sewer area draining into the City of Albany sewage treatment plant. The sewer lines in front of the town houses are new sanitary sewers, which flow into the existing fifteen inch concrete pipe combined sewers.

The total water usage is metered inside each of the town houses and each home owner is billed directly on a bi-annual basis.

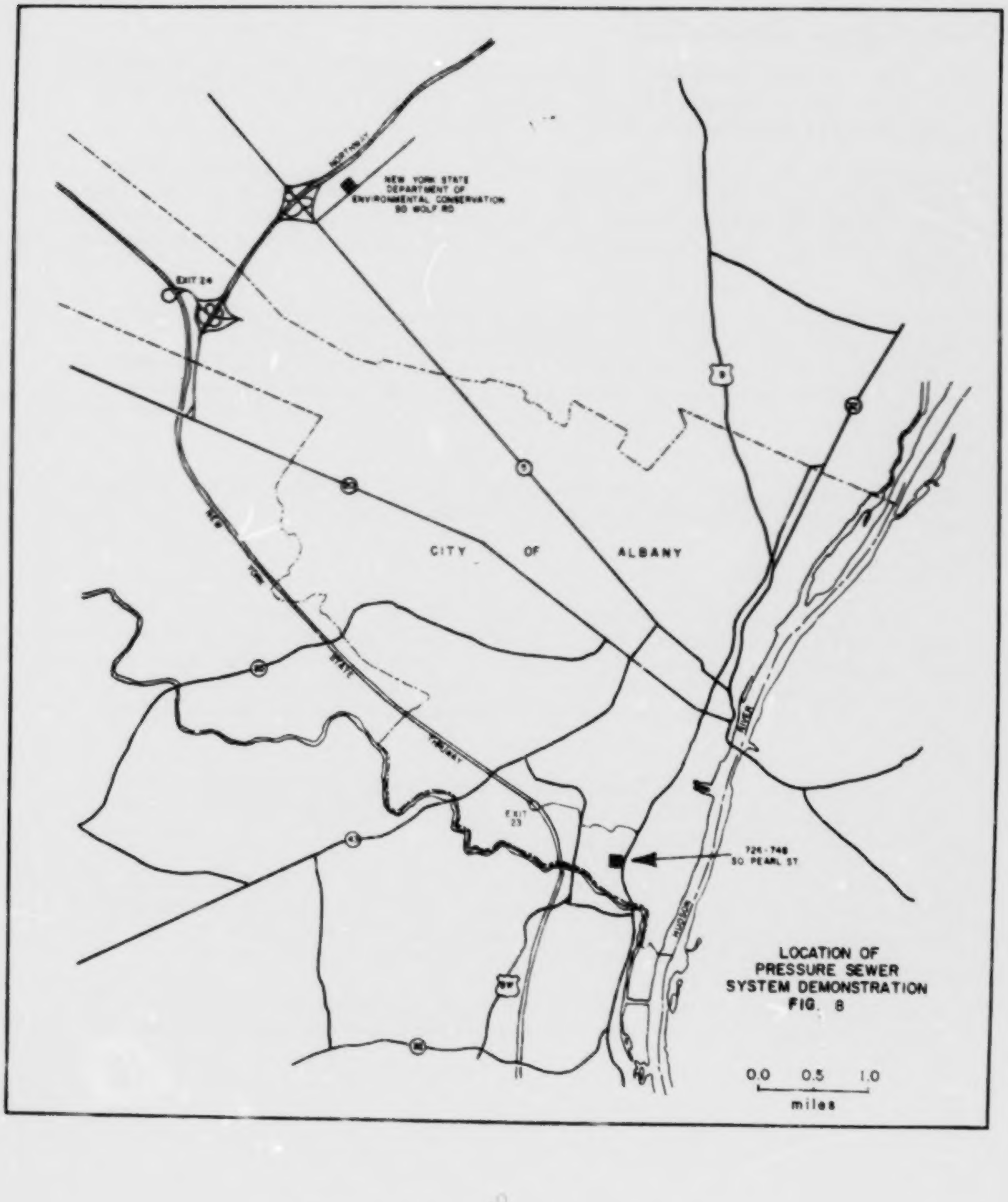
Type of Development

The entire development consists of twenty-three town houses, two stories high, ranging in size from three to five bedrooms. The approximate living area for each house is the same. However, the second floor is divided differently, depending on the number of bedrooms. Five of the twelve test houses have an additional bedroom in the basement (Figure 10).

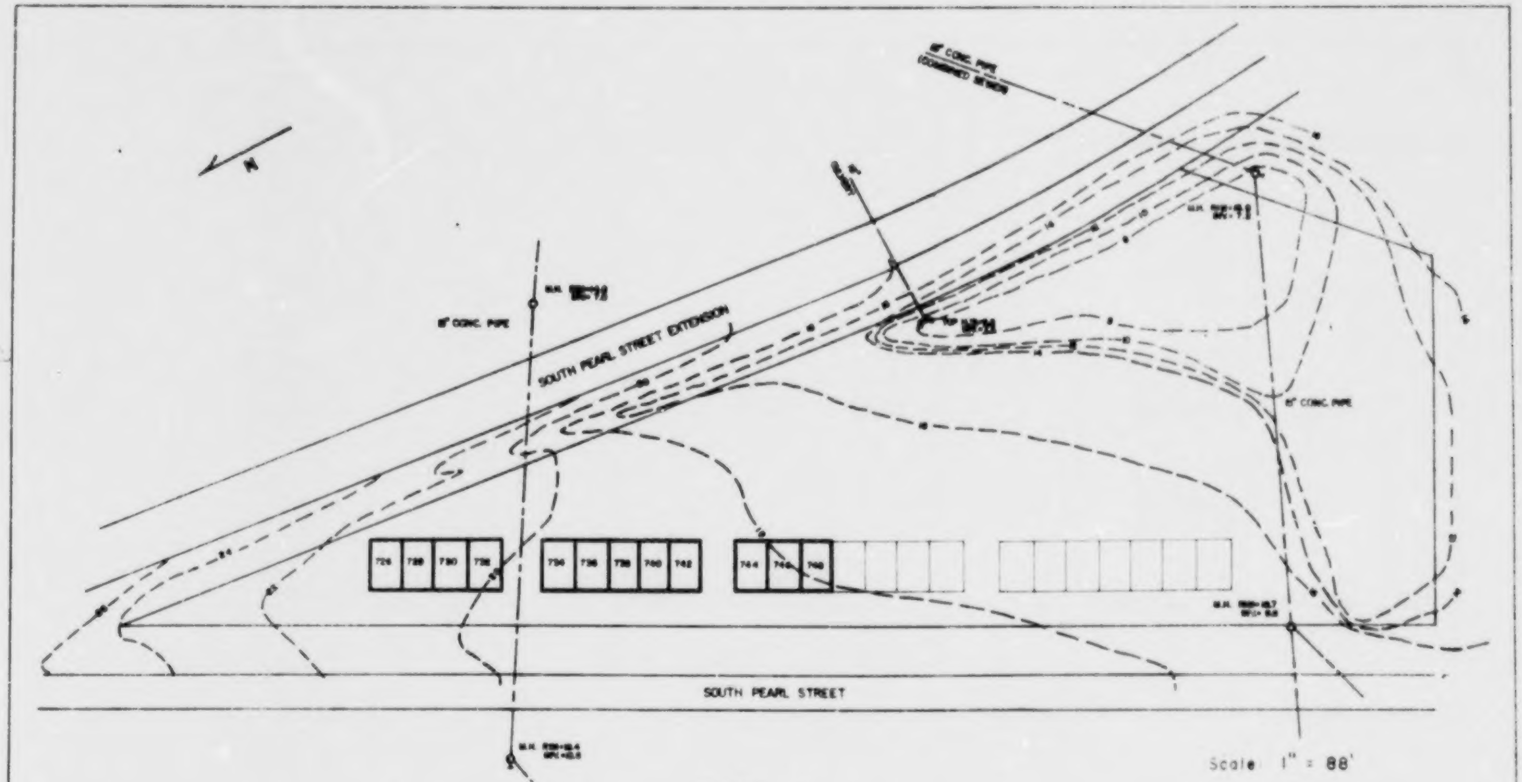
The construction of the twenty-three town houses was started in the Fall of 1969 with the first occupancy in the Winter of 1969-70. The final occupancy occurred December, 1970.

As mentioned before, this was a low income housing project with support from the Federal Housing Administration. The town houses were inspected and approved by FHA personnel. The approximate market value ranges between $17,000 and $21,000 depending on the number of bedrooms.

A survey was conducted at the beginning of the demonstration project in order to become familiar with the home owners and the number of people


NORTHWAY
NEW YORK STATE
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
50 WOLF RD
EXIT 24
9
CITY OF ALBANY
NEW YORK STATE THRUWAY
RIVER
EXIT 23
726-748
SO PEARL ST
HUDSON
9W
0.0 0.5 1.0
miles

LOCATION OF
PRESSURE SEWER
SYSTEM DEMONSTRATION
FIG. 8



N
SOUTH PEARL STREET EXTENSION
SOUTH PEARL STREET
8" CONC. PIPE
CONC. PIPE
(COMBINED SEWER)
8" CONC. PIPE
726
728
730
732
734
736
738
740
742
744
746
748
Scale: 1" = 88'

FIGURE 9

TOWN HOUSE DEVELOPMENT PROJECT
WITH TOPOGRAPHY OF AREA

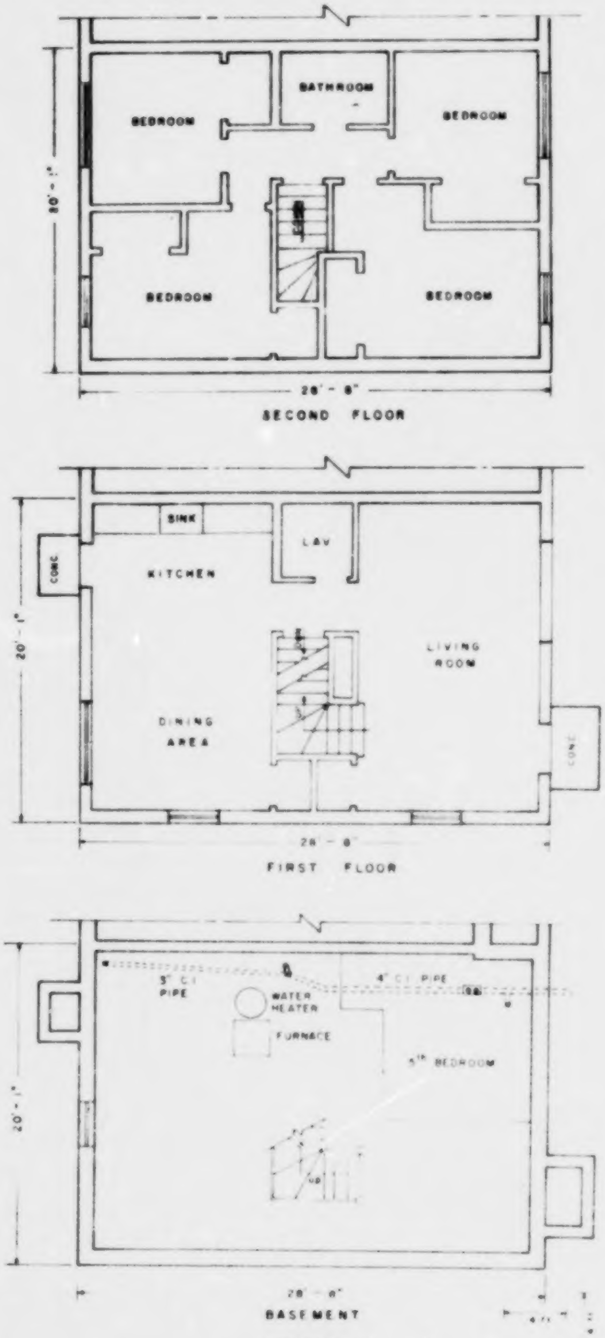

BATHROOM
BEDROOM
BEDROOM
BEDROOM
BEDROOM
20'-1"
28'-8"
SECOND FLOOR
SINK
LAV
CONC
KITCHEN
LIVING ROOM
DINING AREA
CONC
20'-1"
28'-8"
FIRST FLOOR
3" CI PIPE
WATER HEATER
4" CI PIPE
FURNACE
5th BEDROOM
UP
20'-1"
28'-8"
BASEMENT

FIGURE 10
FLOOR PLAN OF TYPICAL TOWN HOUSE

living in each of the town houses. (See Appendix A - Household Survey Information Sheet.) Table 2 summarizes the results of that particular survey.

The demonstration grant provided as an incentive for each of the home owners the cost of the sewer connection from house to street. However, in this particular development the connections had already been made and, therefore, the amount set aside in the grant was paid to the home owners on an equal monthly basis for the duration of the project. An agreement was finalized between the Environmental Conservation Department and each of the home owners for their permission to install a GP unit within each basement and to operate the equipment for a period of at least twelve months but not to exceed eighteen months.

Description of Installation

According to the terms of the grant, twelve GP units would be tested for a period of not less than twelve months.

When the final site was approved, seven of the 23 housing units were completed and ready for occupancy. It was decided not to use these seven housing units since the actual installation of the GP units and the pressure sewer system would not begin for several months but rather use the last twelve housing units to be completed.

This decision afforded us the opportunity to install the GP units, pressure piping, diversion piping and the appropriate electrical wiring before the transfer of ownership was finalized with the individual buyers. Figure 11 shows almost all of the houses used in this demonstration project, with Unit No. 12 (726 South Pearl Street) in the foreground.

The exact installation of the GP units was dependent on the location of the main sewage drainage pipe in the basement. However, an attempt was made to locate the GP units in a portion of the basement where they would not inconvenience the home owners but be readily accessible to our personnel (Figure 12). The wastewater piping system consisted of 4" cast iron pipe vented to the roof and extending underneath the basement floor slab to just outside the building. All the wastewater generated within each housing unit is conducted to the central 4" cast iron pipe with the exception of the kitchen and basement sinks. The drainage pipe serving these two units joins the 4" cast iron pipe under the concrete slab.

It was essential that all the wastewater generated within each of the housing units be delivered to the GP units in order to truly evaluate their performance over the twelve months period.

Accordingly, to accomplish this purpose, a number of diversionary piping systems were investigated using the more conventional piping materials which would comply with the Plumbing Code of the City of Albany.

Some of these proved to be quite expensive while others proved to be most complicated and, therefore, undesirable. Attention was then turned to the

CHARACTERISTICS OF PRESSURE SEWER SYSTEM PROJECT HOMES

TYPE OF HOUSE - 2 STORY TOWN HOUSE
AGE - 1$\frac{1}{2}$ YEARS
LOT SIZE - 20' X 100'
APPROX. MARKET VALUE - $17,000 - $21,000
SOURCE OF WATER - CITY OF ALBANY
WASTE WATER DISPOSAL - CITY SEWER SYSTEM

NUMBER OF \ UNIT		1	2	3	4	5	6	7	8	9	10	11	12
PEOPLE		6	7	9	8	5	5	6	6	8	3	3	9
CHILDREN		4	5	7	6	4	4	4	4	6	2	2	6
BEDROOMS		4	4	5	5	4	4	4	5	5	3	3	5
BATHS		1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1$\frac{1}{2}$	1	1	1$\frac{1}{2}$
DISHWASHERS		0	1	0	0	0	0	0	0	0	0	0	0
WASHING MACHINES	WRINGER	0	0	0	0	0	0	0	0	0	0	0	1
	AUTOMATIC	0	1	1	1	1	1	1	1	1	1	1	0

TABLE 2

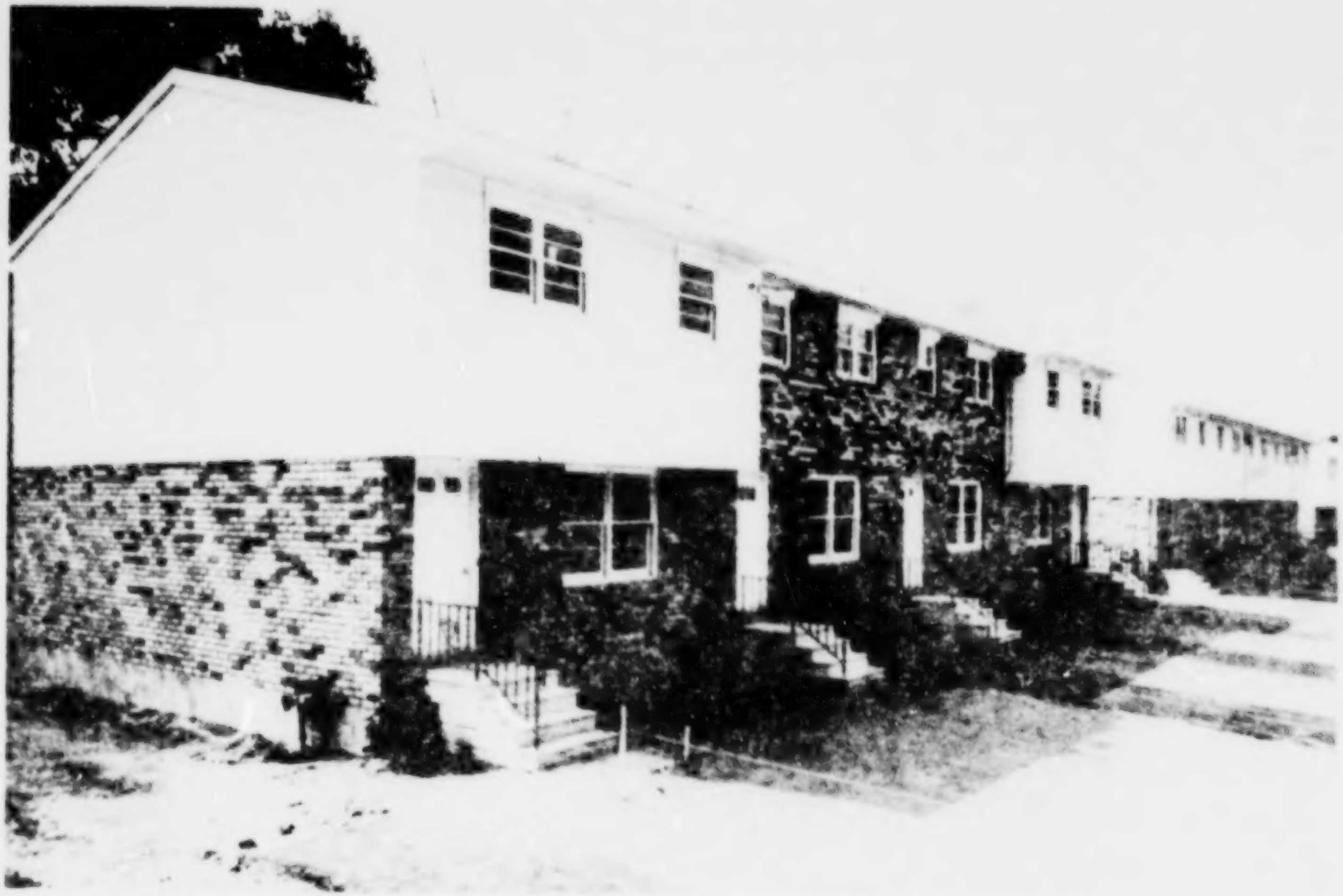


FIGURE 11
PHOTOGRAPH OF TOWN HOUSES

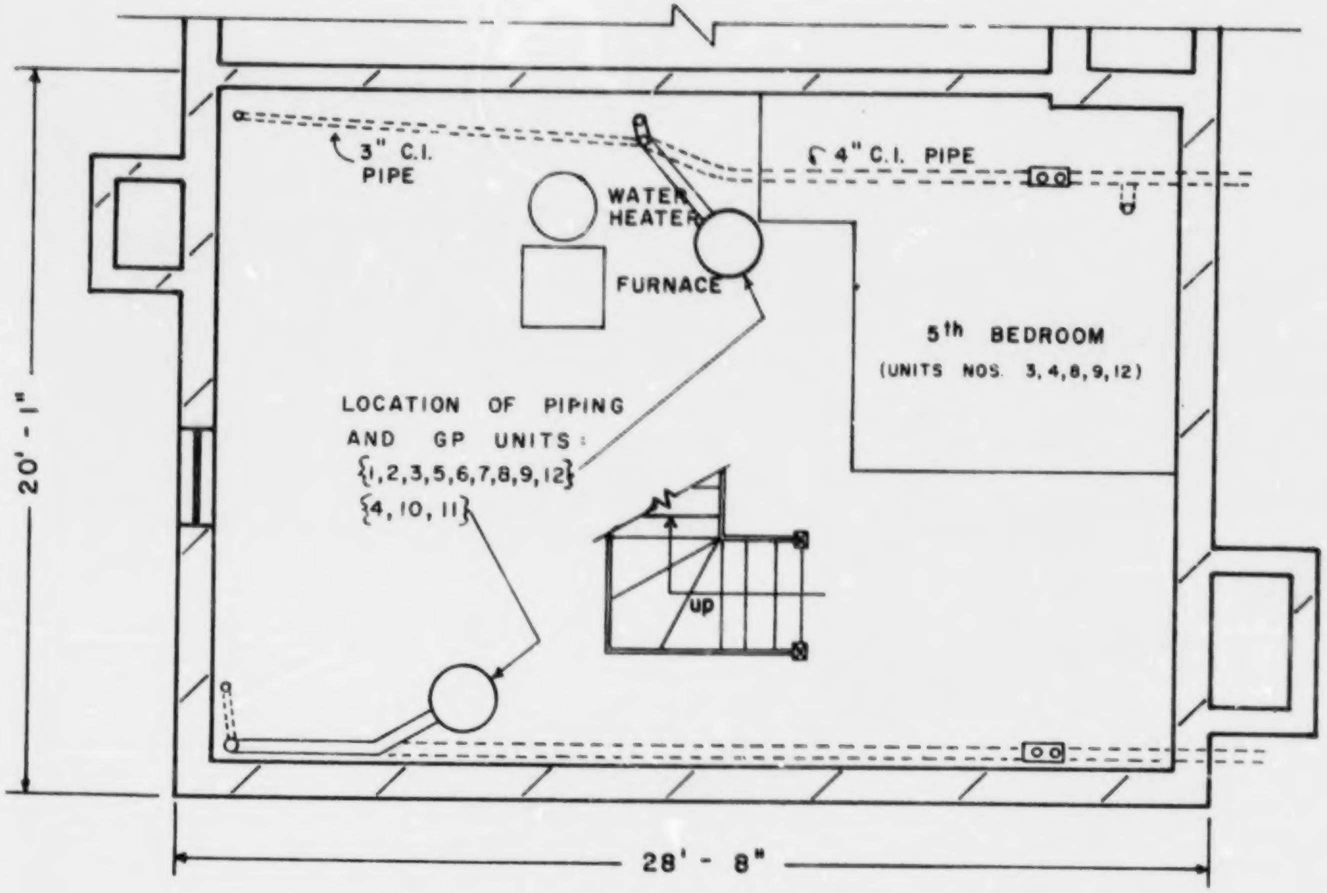

3" C.I. PIPE
4" C.I. PIPE
WATER HEATER
FURNACE
5th BEDROOM
(UNITS NOS. 3, 4, 8, 9, 12)
LOCATION OF PIPING AND GP UNITS:
{1,2,3,5,6,7,8,9,12}
{4, 10, 11}
UP
20' - 1"
28' - 8"

FIGURE 12

LOCATION OF GP UNITS WITHIN BASEMENTS

investigation of other methods not permissible under the existing local Plumbing Code, such as PVC-DWV pipes and fittings. In this particular instance, this new direction proved to be most successful since the PVC-DWV pipes could afford us a rather inexpensive yet workable system.

Since the working area within each of the housing units was confined, it was necessary to design a system that could be easily installed and, at the same time, one which could be readily disassembled during the restoration phase of the project. Figure 13 shows the 4" drainage pipe before and after the necessary piping connections were made.

However, before any work could begin on this phase of the project, it was necessary to obtain a temporary variance in the Plumbing Code from the City of Albany. This variance for the usage of PVC-DWV pipe was allowed for the duration of the demonstration project stipulating that all PVC-DWV pipes had to be installed by plumbers certified by the City of Albany. Upon completion of the project, it was necessary to restore the wastewater system to its former status.

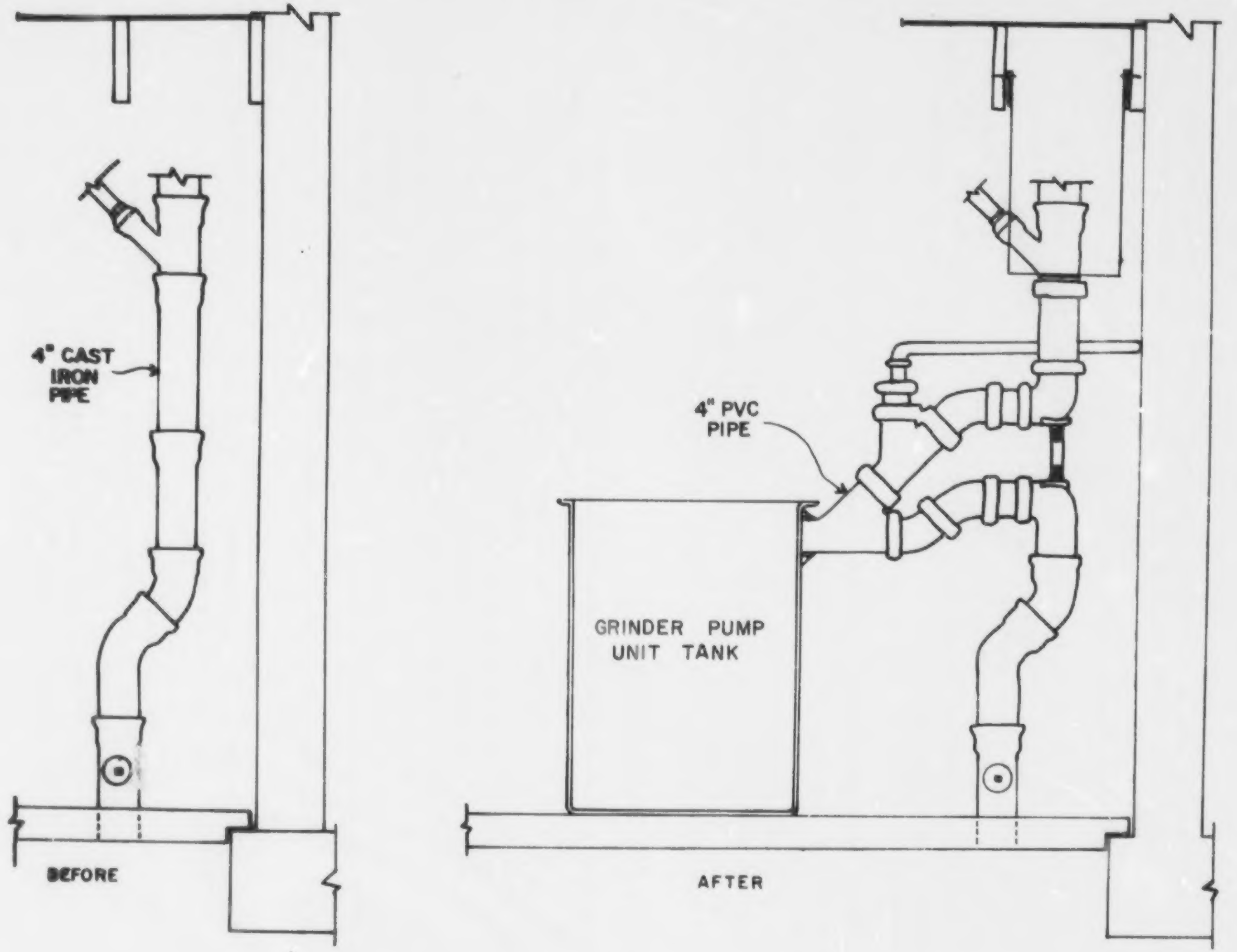
Even though PVC-DWV piping is allowed by many plumbing codes in various cities throughout the State, long-duration performance records are not available and, therefore, revision of codes of the City of Albany to include PVC-DWV piping systems for single or multi-family dwellings have not been contemplated. In this particular project, 4" PVC-DWV fittings and schedule 40 pipes were used to divert the flow to the GP tank. A typical basement installation is shown in Figure 14.

Automatic Monitoring Equipment

The pressure sewer system concept utilizing GP units was one of two systems of this nature ever investigated in the United States; the other, being a small scale version of the Albany project, was carried out in Phoenixville, Pennsylvania by G.E. Company. For this reason, a most thorough automatic data collection system was designed for this demonstration project. In order to properly evaluate the GP units operation, it became necessary to continuously record data on their mechanical performance and the performance of the entire system under all conditions; that is during periods of non-operation and periods of peak operation and peak pressures. However, it was also important to minimize disturbances or inconvenience the home owners at any time. A remote control monitoring system was, therefore, necessary.

The automatic monitoring equipment was the heart of the demonstration data collection effort. It was essential that such a system be properly designed and be very dependable with a minimum of "down time".

The final design of the automatic monitoring equipment was based on the number of parameters needed to properly evaluate the pressure sewer system, and those necessary for the future design of pressure sewer systems. A combination of these two needs determined the final selection of the different parameters. They were as follows:


4" CAST IRON PIPE
BEFORE
4" PVC PIPE
GRINDER PUMP UNIT TANK
AFTER

PVC PIPE DIVERSION SYSTEM

FIGURE 13

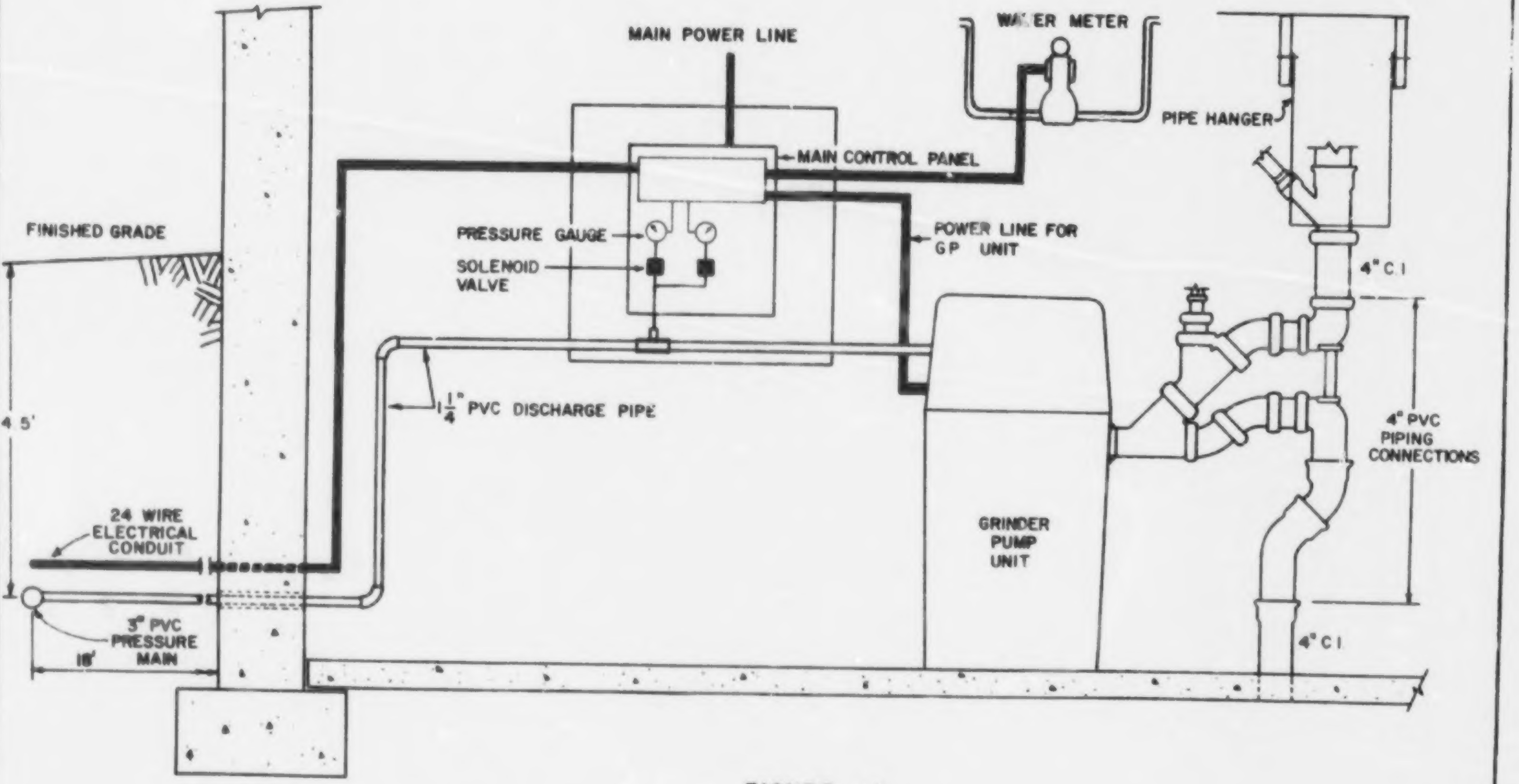

MAIN POWER LINE
WATER METER
PIPE HANGER
MAIN CONTROL PANEL
FINISHED GRADE
PRESSURE GAUGE
SOLENOID VALVE
POWER LINE FOR G P UNIT
4" C I
$1\frac{1}{4}$" PVC DISCHARGE PIPE
4.5'
4" PVC PIPING CONNECTIONS
24 WIRE ELECTRICAL CONDUIT
GRINDER PUMP UNIT
3" PVC PRESSURE MAIN
18'
4" C I

FIGURE 14

TYPICAL INSTALLATION OF GRINDER PUMP UNIT
WITHIN EACH TOWN HOUSE

1. Maximum Pressure
2. Minimum Pressure
3. Water Flow
4. Operating Time (GP Unit)
5. Total Time for any Occurring Overflows
6. Total Operations and Simultaneous Operations

On this basis, a number of electronic systems' components were investigated and other equipment related to the overall systems were also carefully analyzed; such items as paper tapes, magnetic tape, telemetering system, etc. After digesting all the available information, the Environment/One Corporation of Schenectady, N.Y., which was selected from several contractors, proposed a monitoring system shown in Figure 15 and 16.

The monitoring system received 65 simultaneous inputs (a total of 100 inputs were available). These electrical inputs were recorded on punched tape (mylar or paper) every fifteen minutes for the duration of the project. Practical and economic constraints dictated the fifteen minute interval, even though shorter time intervals were available.

The major electronic components, manufactured by United Systems Corporation - Digitec, were closely integrated by the Environment/One Corporation engineers with a multiplicity of electrical motor, timers, relays, etc., which were utilized to measure the individual parameters (Figure 17).

After the first two months of operation, it was apparent that additional and much more accurate information was warranted in the area of the GP units daily operations. The original monitoring equipment recorded the total running time but could not discriminate as to the number of actual operations within each fifteen minute time period. As a result, the computer's summary sheets reported incorrectly the total number of operations. In actuality, the number reported corresponded to the total daily active periods for any given GP unit. An active period is defined as a unit of time (fifteen minutes in this case) during which the GP unit's motor was in operation at least once. Ninety-six (96) is the maximum number of active periods recorded in a single day during this demonstration project.

In order to rectify this deficiency in the data collection system, a twelve channel event recorder was installed on the automatic monitoring system on January 4, 1971. In addition, the strip chart produced by the event recorder made it possible to accurately enumerate all simultaneous operations. This is a vital parameter in the design of a pressure sewer system, since it helps to determine the probability of maximum peak flows, and therefore, the peak hydraulic gradient line, upon which the system dynamic head loss calculations can be based.

Description of Parameters

(1) (2) Maximum and Minimum Pressure

The original prototype GP unit was designed to operate efficiently between

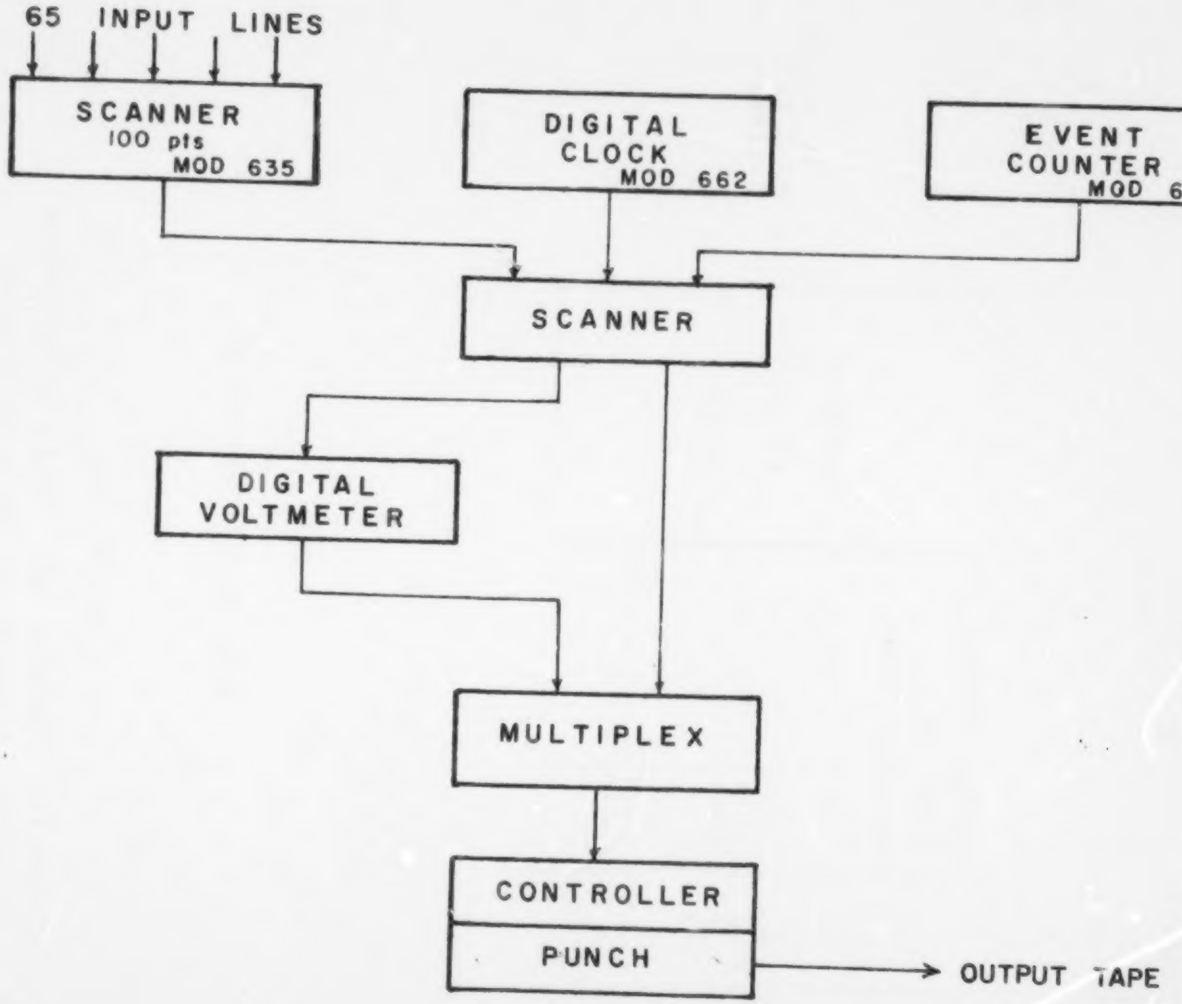
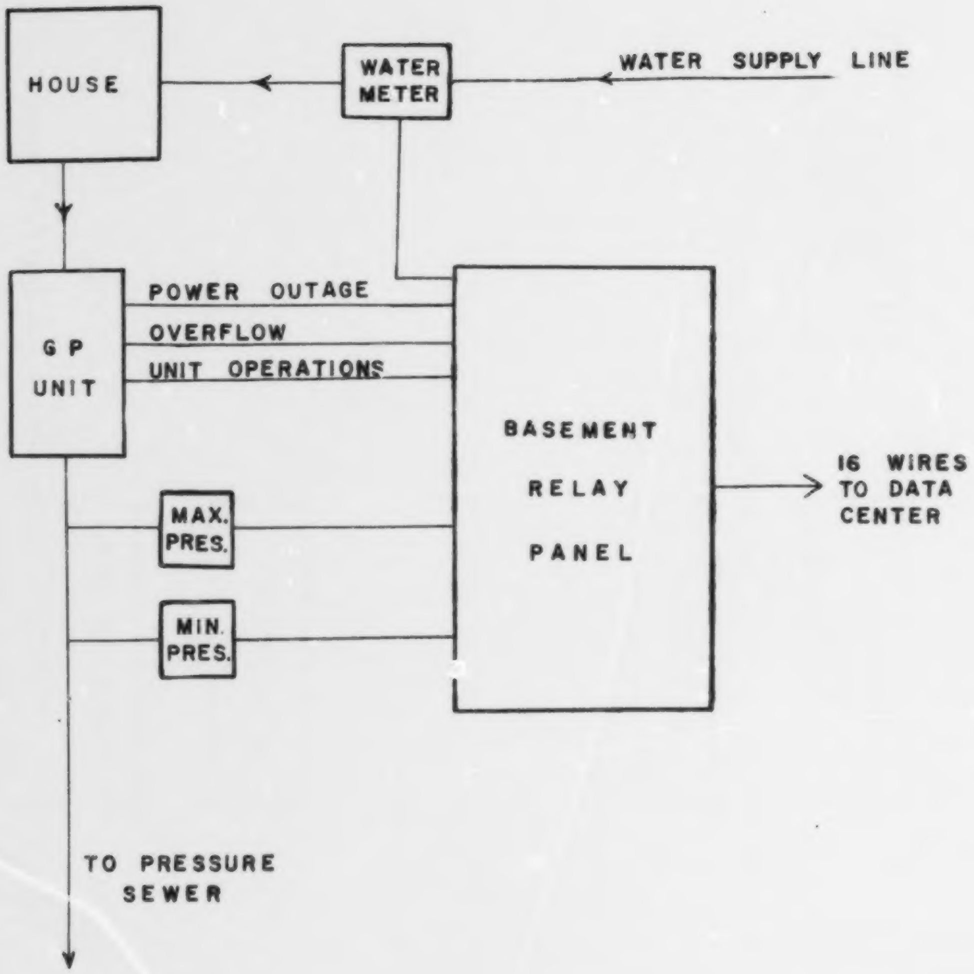

65 INPUT LINES
SCANNER
100 pts
MOD 635
DIGITAL
CLOCK
MOD 662
EVENT
COUNTER
MOD 654
SCANNER
DIGITAL
VOLTMETER
MULTIPLEX
CONTROLLER
PUNCH
OUTPUT TAPE

FIGURE 15
SCHEMATIC DIAGRAM OF AUTOMATIC MONITORING EQUIPMENT LOCATED IN DATA CENTER (TRAILER)


HOUSE
WATER METER
WATER SUPPLY LINE
G P UNIT
POWER OUTAGE
OVERFLOW
UNIT OPERATIONS
BASEMENT RELAY PANEL
16 WIRES TO DATA CENTER
MAX. PRES.
MIN. PRES.
TO PRESSURE SEWER

BASEMENT SYSTEM

FIGURE 15

SCHEMATIC DIAGRAM OF DATA ACQUISITION SYSTEM LOCATED IN EACH BASEMENT

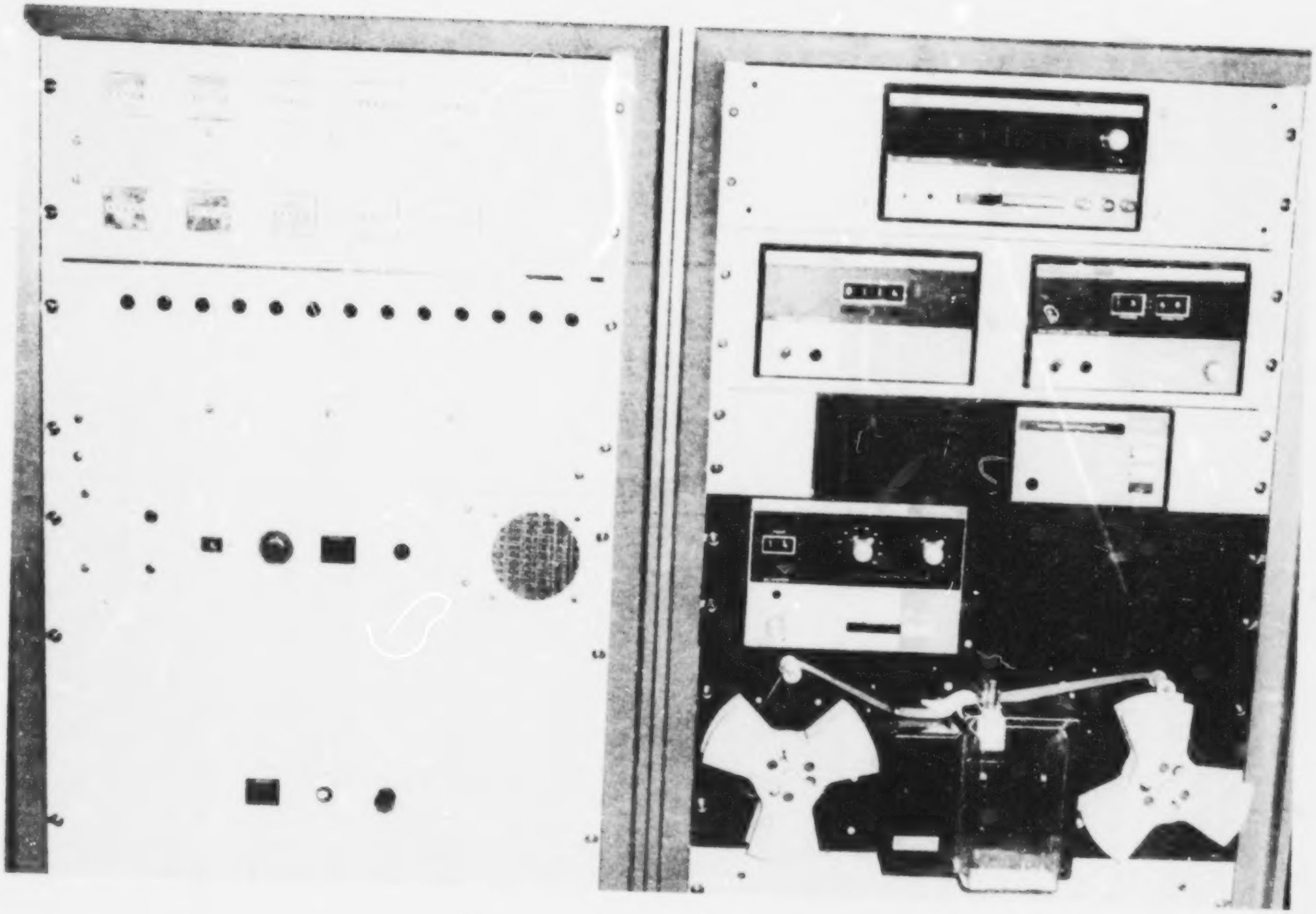


FIGURE 17
PHOTOGRAPH OF AUTOMATIC MONITORING
SYSTEM INSIDE FIELD OFFICE TRAILER

0 and 35 psig pressure. Therefore, it was necessary to confirm this operating pressure range for the prototype and modified GP units. This particular pressure sewer project was designed and installed with a minimal pressure head, around 2 to 3 psig. The system was then operated for a period of time at this constant static head. It was during this time that GP units were closely watched in order to document malfunctions and to test necessary modifications of the GP units. Also it was during this same period that the necessary critical design modifications in the prototype GP units became apparent.

Toward the termination phase of the project, the static head was increased in a series of steps to the maximum recommended working pressure head of 35 psig.

The maximum and minimum pressure gages were located inside each basement installation connected to the 1¼ inch PVC discharge pipe approximately three to six feet downstream from the GP unit (Figure 18).

The first of two gages registered the maximum pressure achieved in the pressure sewer system during any portion of a fifteen minute period, while the second gage registered the minimum pressure during the same fifteen minute period.

One-way instrument check valves held these high and low values firm until the automatic monitoring equipment recorded them, at which time two, two-way solenoid valves were activated. This reset both pressure gages to the present pressure head within the 1¼ inch pipe. This cycle was repeated for every active period.

The two Bourns Model pressure gages were equipped with a 2,000 ohm potentiometric transducer for remote recordings.

A 10 volt power supply applied a constant voltage across the transducer which, in turn, relayed back to the automatic monitoring equipment corresponding maximum and minimum pressure head values (Figure 19). Basically then, the pressure transducers had a calibration constant of 10 psig per volt.

All pressure gages were calibrated during the installation period (Figure 20). These calibration values were then fed to the computer so that the individual pressure heads at the twelve GP unit installations could be calculated.

As expected, during periods of non-usage, the pressure was at a minimum; that is, it was approximately equivalent to the static head of the system. On the other hand, during periods of high usage, such as four GP units operating simultaneously, a maximum pressure for the system was reached.

(3) Water Flows

A Neptune Water Meter (Figure 21) especially fitted with a potentiometric transducer was installed in each basement in addition to the city's water

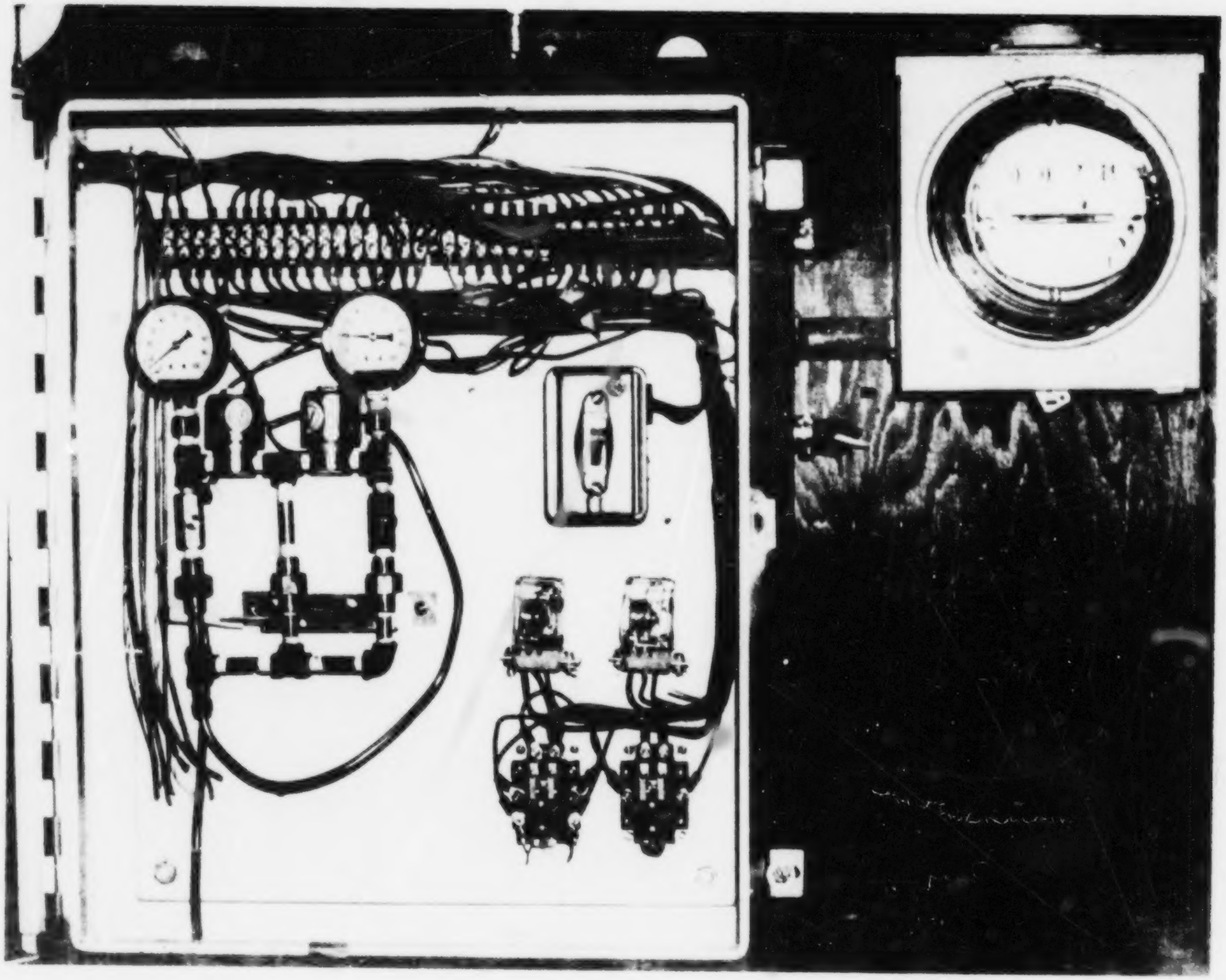
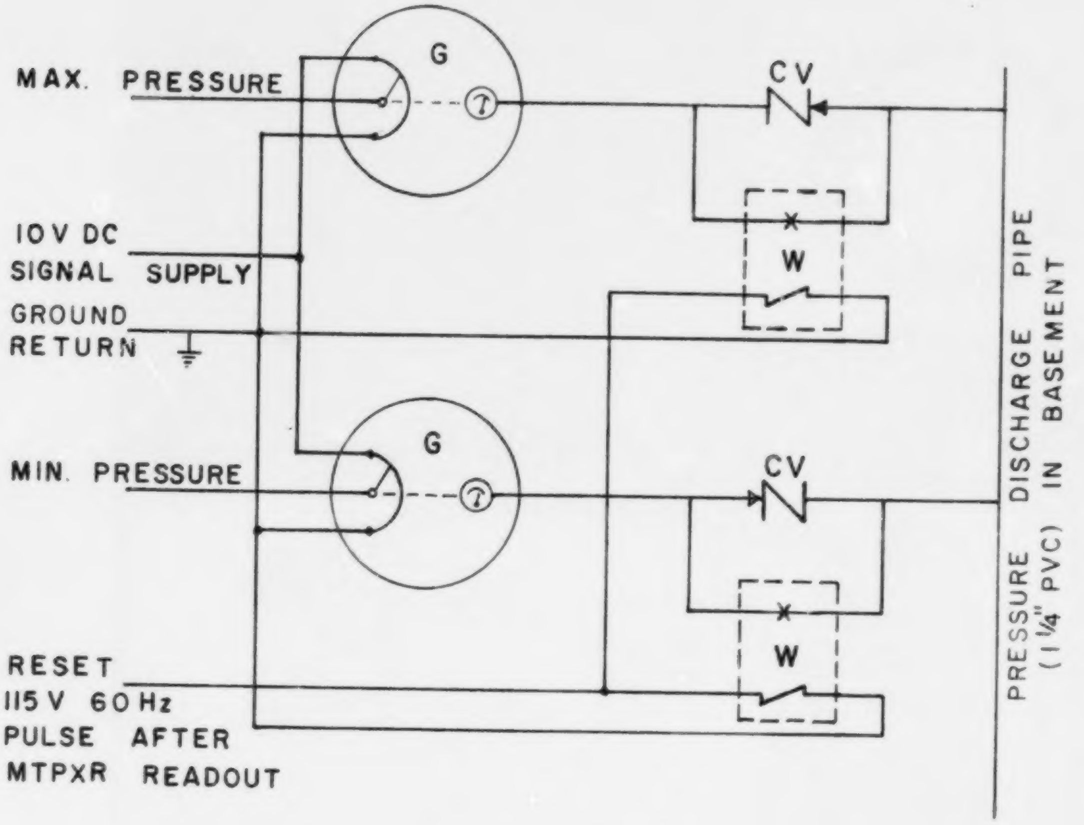


FIGURE 18
PHOTOGRAPH OF PRESSURE GAGES
INSTALLATION WITHIN TEST HOUSE


MAX. PRESSURE
G
CV
10V DC SIGNAL SUPPLY
GROUND RETURN
W
MIN. PRESSURE
G
CV
W
RESET 115V 60Hz PULSE AFTER MTPXR READOUT
PRESSURE DISCHARGE PIPE (1 1/4" PVC) IN BASEMENT

G - PRESSURE GAGE. BOURNE MODEL 200 · 312 · 6030 WITH 2000 OHM POT.

CV - CHECK VALVE. SKINNER CAT. F311-200

W - 2 WAY SOLENOID VALVE SKINNER CAT. C2DB 1277 7 WATTS

PRESSURE SENSING SYSTEM

FIGURE 19

PRESSURE GAUGE CALIBRATIONS

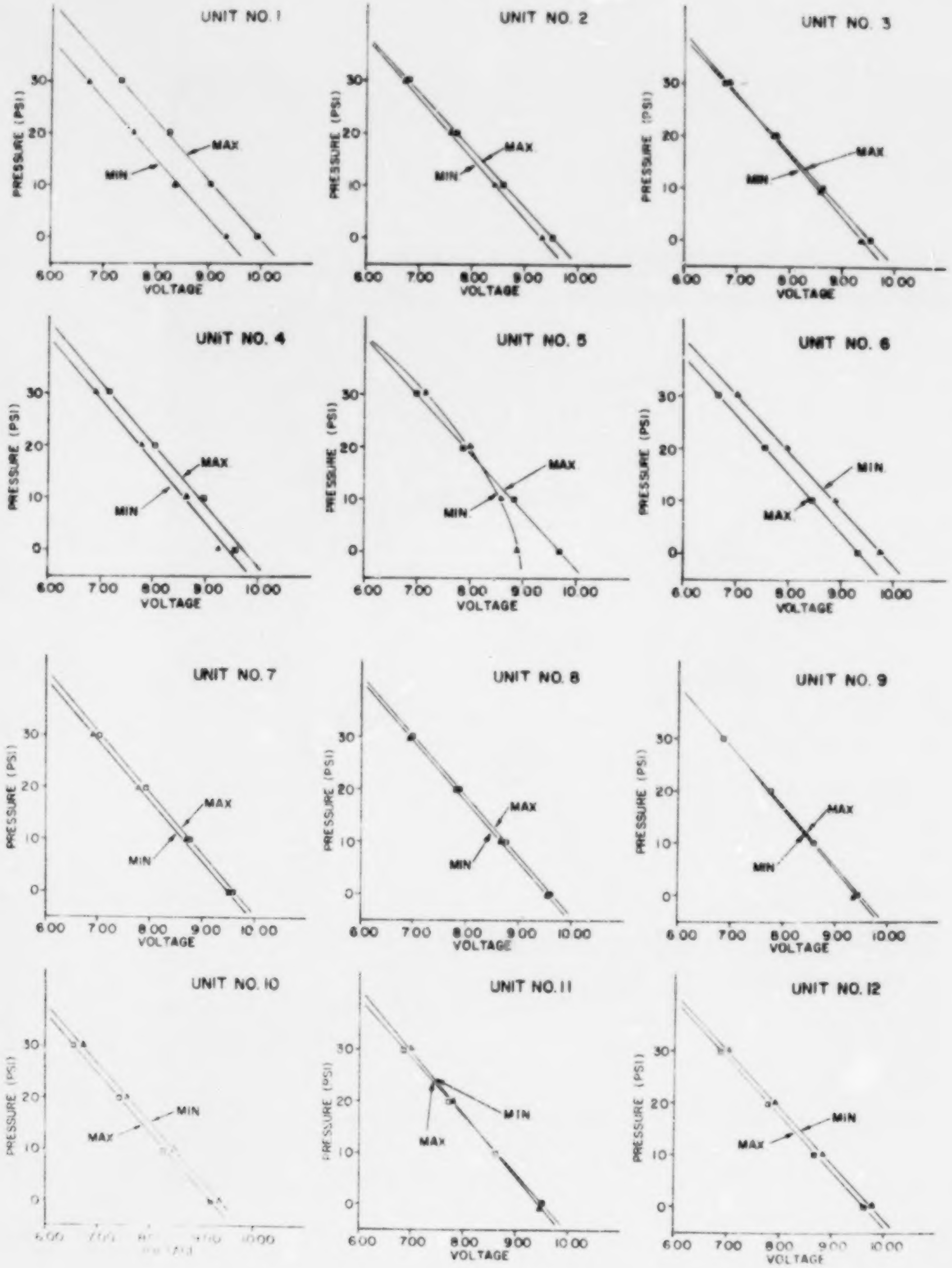


FIGURE 20

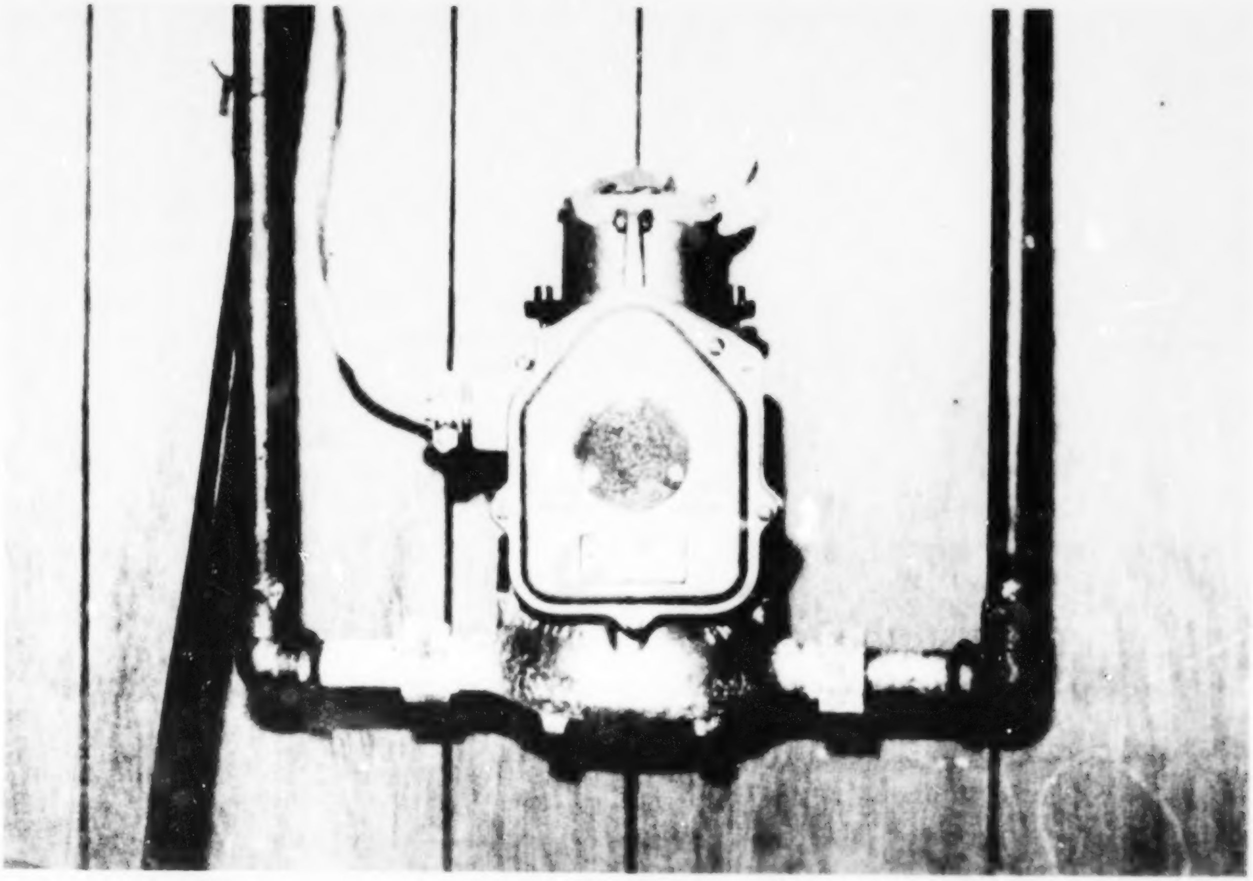


FIGURE 21

PHOTOGRAPH OF WATER METER INSTALLATION

meter. The purpose of the additional meter was to record only that portion of water used within the individual homes. Any outside usage, such as car washing, lawn watering, etc. was eliminated from being recorded by simply installing the outside water lines before the project's water meter.

Just as in the case of the first two parameters, the water flow measurements were based on a 10 volt system. For instance, a one volt differential indicated a 10 gallon water consumption while a complete rotation of the potentiometric transducer was equivalent to 100 gallons consumption (Figure 22).

The wastewater flow was then directly related to the water flows of each home. All data relevant to water and wastewater flows is presented in the Hydraulic Section of this report.

(4) GP Units' Total Operating Time

The automatic monitoring equipment located in the field office trailer contained small electrical motors coupled to continuous rotation potentiometers, which were connected by underground cables to each of the twelve GP units' motors.

During a normal operating cycle, the GP motor and the smaller electrical motor in the field office trailer were activated simultaneously. The potentiometer was rotated by the motor relaying a changing voltage value to the scanner.

The voltage differential between the start and conclusion of an active period corresponded to the total running time of any GP unit. Since everything was based on a 10 volt system, a one volt differential was indicative of a 1.5 minutes total operating time (Figure 23).

(5) Overflow Time

The "overflow time" parameter was an essential part of the project since it was needed to verify the adequacy of the peak flow storage capacity of the GP tank. It was necessary to document those occasions when the rate of wastewater flow into the tank was higher than the GP unit's pumping rate for a long enough time to exceed the storage capacity of the tank. If the frequency of this occurrence was high enough, a modification of the tank size would be indicated.

An exact duplicate of the system described in the previous section was designed and installed for the measurement of the "overflow time" parameter. However, instead of coupling this system to the operating cycle of the GP unit, it was connected to a float switch located near the top of the GP tank as shown in Figure 24.

Therefore, a complete rotation of the potentiometer was equivalent to a fifteen minute "overflow time". If the overflow condition existed for more than one active period, then that total "overflow time" appeared

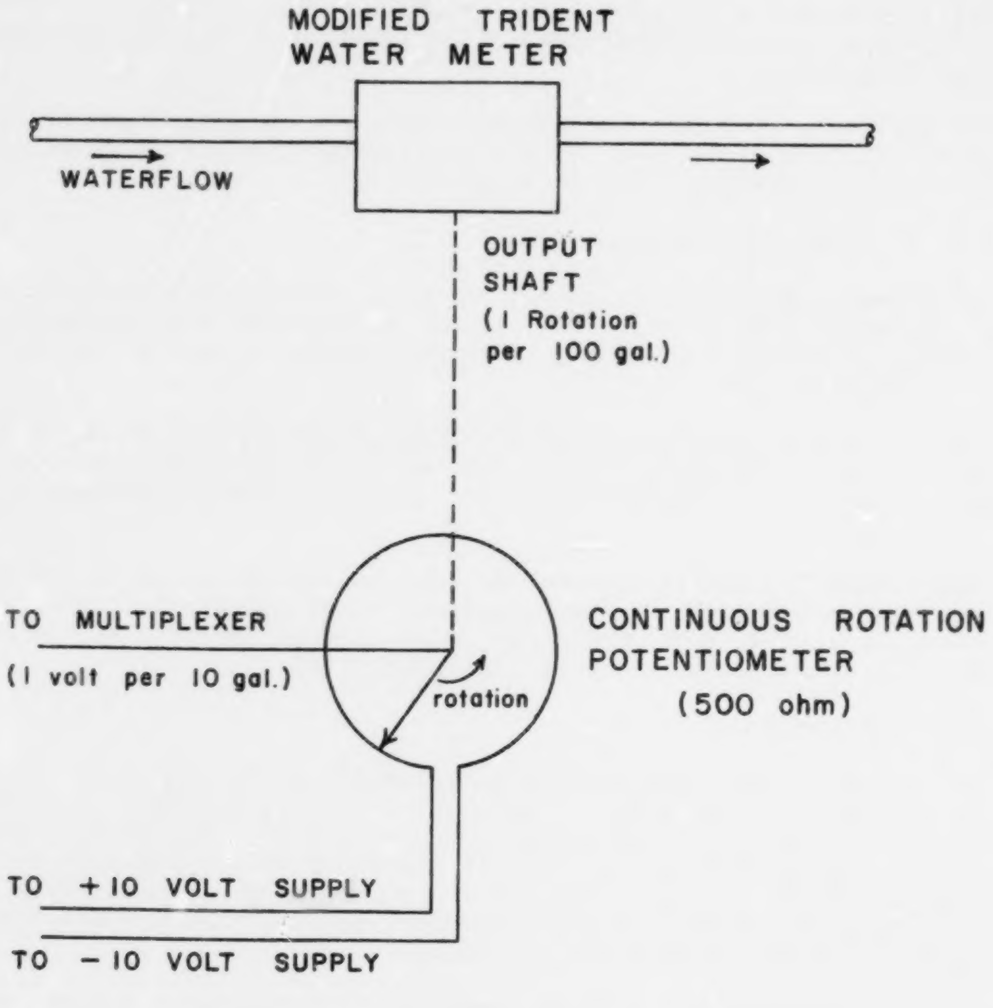

MODIFIED TRIDENT WATER METER
WATERFLOW
OUTPUT SHAFT (1 Rotation per 100 gal.)
TO MULTIPLEXER
(1 volt per 10 gal.)
rotation
CONTINUOUS ROTATION POTENTIOMETER (500 ohm)
TO +10 VOLT SUPPLY
TO −10 VOLT SUPPLY

FIGURE 22

SCHEMATIC OF WATER METERING SYSTEM

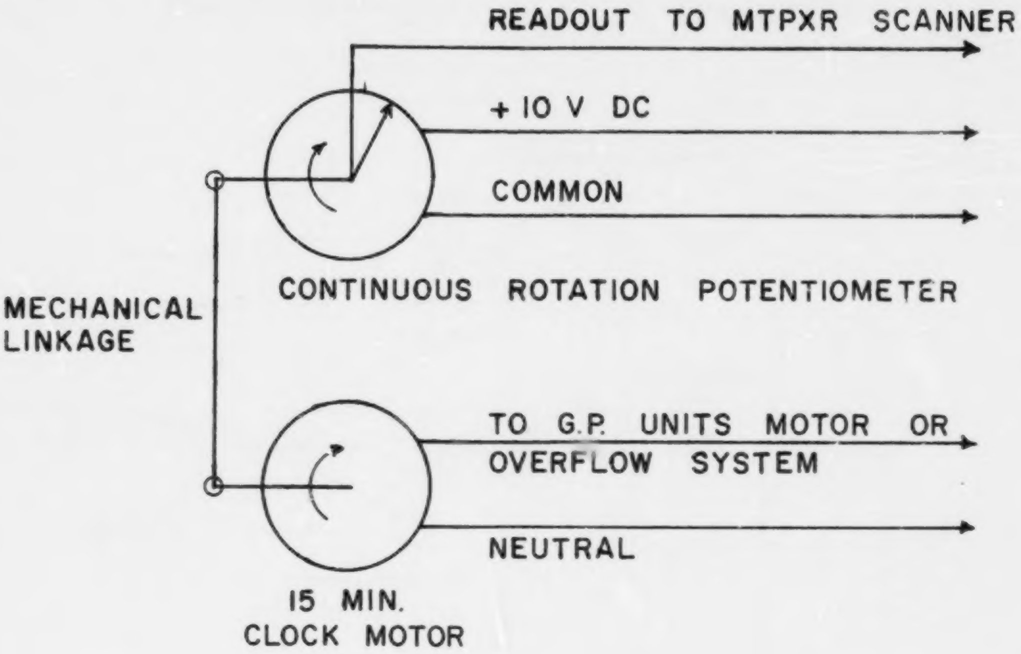

READOUT TO MTPXR SCANNER
+10 V DC
COMMON
CONTINUOUS ROTATION POTENTIOMETER
MECHANICAL LINKAGE
TO G.P. UNITS MOTOR OR OVERFLOW SYSTEM
NEUTRAL
15 MIN. CLOCK MOTOR

FIGURE 23

SCHEMATIC OF SYSTEM FOR RECORDING TOTAL RUNNING AND OVERFLOW TIME FOR GP UNITS

CROSS SECTION OF GP UNIT WITH LOCATION OF LEVEL AND OVERFLOW RECORDING FLOATS

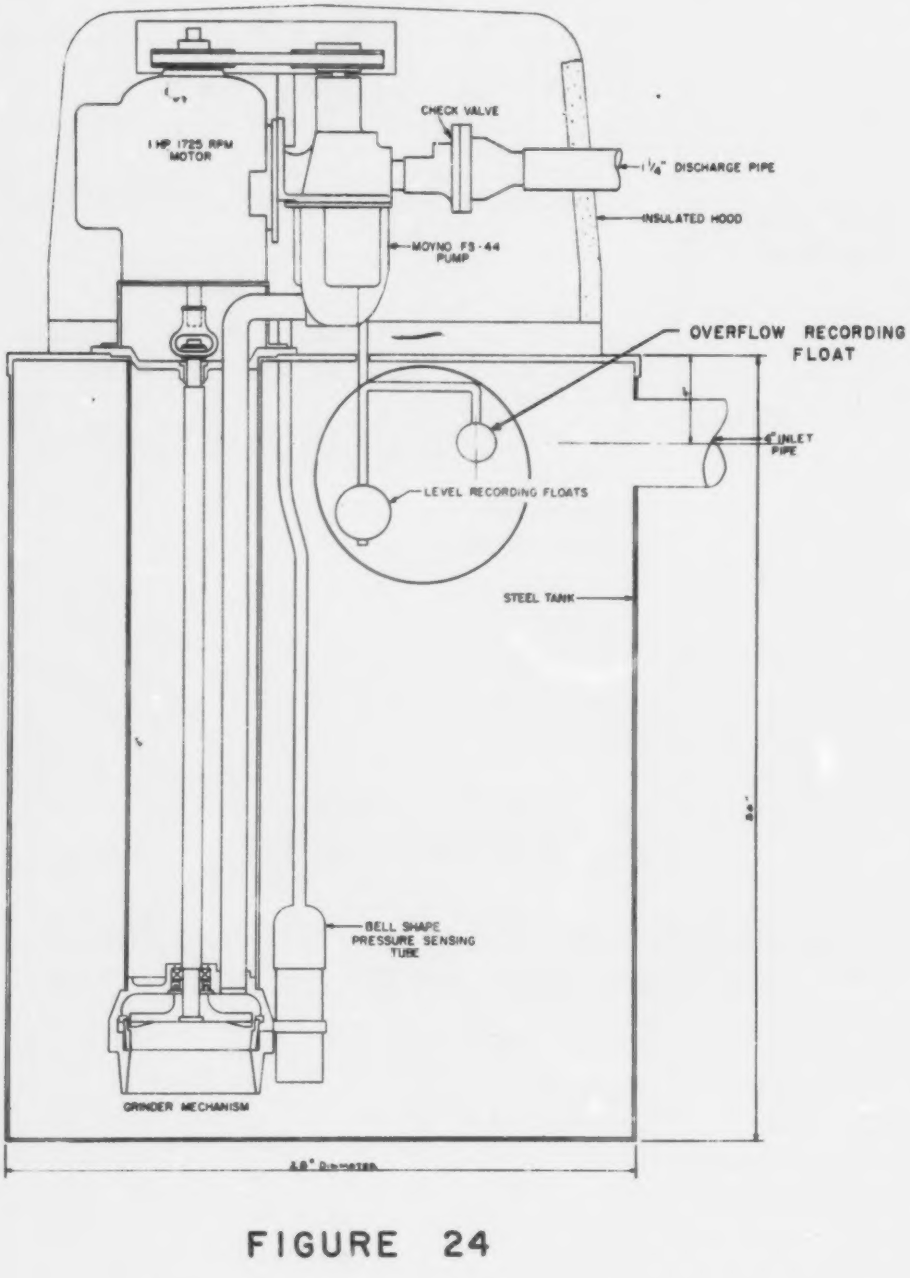

CHECK VALVE
1 HP 1725 RPM MOTOR
1 1/4" DISCHARGE PIPE
INSULATED HOOD
MOYNO FS-44 PUMP
OVERFLOW RECORDING FLOAT
4" INLET PIPE
LEVEL RECORDING FLOATS
STEEL TANK
BELL SHAPE PRESSURE SENSING TUBE
GRINDER MECHANISM

FIGURE 24

in the Daily Summary Sheet in the appropriate column for the respective GP unit. The float switch was installed in the prototypes especially for this project and would not be normally found in a commercially manufactured GP unit.

The second float switch was utilized to activate the alarm system of the monitoring equipment. A somewhat similar alarm system can be found in the commercially available units which would warn the home owner of a failure within the unit.

(6) Total Operations and Simultaneous Operations

Twelve small event counters were installed as part of the monitoring equipment, which recorded the total operations of the individual GP units. These counters were not scanned automatically by the monitoring equipment but the values were read manually by the project staff at infrequent intervals. Although every attempt was made to record the total monthly operations for the GP units, it became evident that this was not an adequate experimental procedure. Therefore, new methods were immediately investigated. The solution was an automatic event recorder capable of continuously tracking a minimum of twelve events simultaneously.

At the conclusion of the third month of the project, a fifteen channel Esterline Angus Event Recorder was installed. Not only were all the GP units operations graphically recorded but so were all simultaneous occurrences. Although this information had to be manually transcribed, the results proved invaluable in the final evaluation of the pressure sewer system.

Reporting of Malfunction Occurrences

The automatic monitoring system was equipped with a "Teleguard" unit capable of warning project personnel of any malfunction occurrences. Basically, the "Teleguard" system was activated by any one of four possible malfunctions:

(1) Total Power Failure
(2) GP Unit in Overflow Stage
(3) GP Unit's Motor Continuously Running
(4) Disruption of the Tape Recording Mechanism

Upon activation, the "Teleguard" system automatically dialed three telephone numbers and played a pre-recorded message, giving indication that a malfunction had occurred. A member of the research staff was then dispatched to the project site and investigated the cause of the malfunction. If corrective measures were possible, these would be taken immediately; if not, the necessary repairs would be postponed until a more opportune time.

A broken tape or a total power failure was detected easily. However, two special electrical systems were installed in order to precisely locate the two other malfunctions, avoiding any unnecessary inconvenience to the home owners. Two sets of lights on the monitoring equipment provided visual indication of the location of the malfunction.

Project's Daily Operational Procedure

The two major objectives in the daily operations of the pressure sewer system demonstration consisted of:

(a) Maintaining the automatic monitoring equipment in proper functioning order;

(b) Documenting and repairing any and all malfunction occurrences within the pressure sewer system.

The automatic monitoring system had to perform as efficiently as possible in order to supply the data necessary for the final evaluation. A fresh supply of tape had to be installed on the monitoring equipment every forty-eight hours, based on an average usage of 76 out of 96 active periods per day. During periods of high usage, the tape was exhausted in less than forty-eight hours so that daily visits to the project were necessary.

For weekends and long holiday periods, an expensive Mylar base tape was used. This thin, yet strong, tape permitted recording nearly 86 hours continuously, eliminating the need for a visit to the project site.

Environment/One Corporation prepared a computer program used in summarizing the daily project operating status based on the information gathered by the automatic monitoring equipment. Time-Sharing Computer Services were utilized for all of the computational work. The raw data was fed to the computer and stored in a file. At the end of a week's storage, the special computer program, named "Daily" (see Appendix B), processed the file and printed a daily summary sheet, indicative of the operational status of the project.

Figure 25 illustrates the format of the raw data with the fifteen minute block being emphasized. On occasion, a bad block of data was produced by the automatic monitoring equipment. When this occurred, the program, named "Daily", automatically omitted the erroneous block of data.

Basically, the daily summary sheet reported seventeen (17) different parameters (Figure 26). Each of these parameters is described briefly below:

(1) Daily Maximum Pressure - Max. pressure achieved within the 1¼ inch discharge pipe during the twenty-four hour period.

(2) Maximum Non-operational Pressure - Maximum pressure achieved with the 1¼ inch discharge pipe during a non-operational period.

```
100 2015
988 935 368 485 325 946 0611
926 567 021 801 943 932 1200
443 388 100 953 924 004 1810
815 721 964 883 414 929 2410
235 924 961 304 116 840 3011
954 940 710 330 354 949 3600
946 870 876 023 863 931 4211
792 562 614 917 927 058 4800
869 049 943 938 159 850 5411
574 958 967 821 096 508 6011
977 939 384 959 003 991 6600
100 2030
988 935 227 588 325 946 0611
938 563 021 801 854 936 1200
337 434 100 953 924 964 1810
815 721 924 884 325 929 2410
235 919 961 304 116 840 3011
954 940 693 330 354 949 3600
946 869 876 023 944 934 4211
790 562 614 917 927 011 4800
869 049 944 938 141 850 5411
574 958 967 821 096 508 6011
976 940 384 959 003 991 6600
100 2045
988 935 146 588 325 946 0611
929 506 084 801 849 932 1200
278 482 100 953 924 920 1810
896 721 931 884 324 929 2410
235 922 961 304 116 840 3011
954 940 661 331 354 949 3600
946 713 962 023 944 934 4211
790 562 614 917 927 011 4800
905 049 944 938 087 850 5411
574 964 967 [illegible] 096 508 6011
978 938 384 959 003 991 6600
100 2100
988 935 084 675 325 946 0611
932 502 084 801 880 932 1200
208 481 100 953 924 909 1810
896 721 941 884 321 929 2410
235 923 961 304 116 840 3011
954 940 661 330 354 949 3600
945 662 979 023 944 932 4211
790 562 614 917 927 011 4800
905 049 943 938 087 850 5411
574 964 967 821 096 508 6011
979 939 384 959 003 991 6600
```

15 MINUTES
OUTPUT

FIGURE 25

RAW COMPUTER OUTPUT DATA

```
DAILY REPORT OF OPERATIONS - PRESSURE SEWER DEMONSTRATION    09/21/71
    RUN # 419

HOUSE NUMBER                        1     2     3     4     5     6      7     8     9    10    11    12

DAILY MAXIMUM PRESSURE           35.9  19.8   8.4   7.6   9.9   3.6   24.1  13.0  19.0  23.0  10.7  12.2   35.9
MAX. NON-OP. PRESSURE            32.7  18.6   6.4   7.6   9.9   3.6    9.7  13.0  11.9   9.8  10.6  12.2
AVERAGE MAXIMUM PRESSURE         16.8  10.3   4.2   6.3   7.8   0.8    9.0  11.6   9.7   6.5   7.1  10.0
AVERAGE MINIMUM PRESSURE          4.0   1.9   3.0   3.4   3.0   3.4    4.2   2.9   3.4   1.3   2.1   2.4

PEAK 15 MIN. FLOW RATE           16.9  30.0  29.0  53.3  19.2   0.0   27.5  19.8  39.1  13.6  19.6  18.0   92.0
PEAK 1 HR FLOW RATE              25.0  43.3  33.3  76.3  25.2   0.0   36.0  24.7  65.6  24.9  35.8  24.5  161.2
DAYTIME FLOW                    176.4 189.5 306.0 253.6 107.3   0.0  156.1 265.2 364.4  58.7 100.8 183.6 2181.6
NIGHTTIME FLOW                   54.3  21.8  62.0  95.9  28.4   0.0   55.2  21.2  34.7  10.1  17.6  64.6  465.8
TOTAL FLOW                      230.7 211.3 368.0 349.5 135.7   0.0  211.3 286.4 399.1  68.8 118.4 248.2 2647.4

NUMBER OF OVERFLOWS                 0     0     0     0     0     1      0     0     0     0     0     0
POWER OUTAGE INTERVALS              0     0     0     0     0    87      0     0     0     0    89     0
NUMBER OF DAILY OPERATIONS         19    12    27    27     9     0     16    31    28     6     2    16
TOTAL OPERATING TIME             16.2  14.6  28.5  23.3   9.7   0.0   13.7  27.8  28.5   4.1  11.5  16.9
AVERAGE PUMP RATE(GPM)           14.2  14.5  13.6  15.0  14.0   0.0   15.4  10.3  13.9  16.6  10.3  14.7



NUMBER OF ACTIVE PERIODS           84

TIME OF MAX. PRES.              01:30 18:45 19:15 00:00 20:00 21:30  20:30 10:00 17:45 07:15 20:30 23:00  00:00
TIME OF MAX. FLOW               16:30 18:45 20:15 22:00 07:30 08:15  21:00 17:15 16:00 07:15 20:45 21:45
```

FIGURE 26 DAILY SUMMARY SHEET

(3) Average Maximum Pressure - Average maximum pressure based on the total number of active periods.

(4) Average Minimum Pressure - Average minimum pressure as recorded by the second pressure gage based on the total number of active periods.

(5) Peak Fifteen Minute Flow Rate - Maximum water flow rate as registered by the water meter during any fifteen minute period.

(6) Peak One Hour Flow Rate - Maximum water flow rate registered by the water meter during any one hour period.

(7) Daytime Flow - Total water flow from 6:00 A.M. to 10:00 P.M. of a given day.

(8) Nighttime Flow - Total water flow from 10:00 P.M. to 6:00 A.M. of a given day.

(9) Total Flow - Total daily water flow (equivalent to daytime + nighttime flow).

(10) Number of Overflows - The number of active periods during which an overflow occurrence was recorded.

(11) Power Outage Interval - The number of active periods during which electrical power was not available to the individual GP unit.

(12) Number of Daily Operations - The number of active periods during which the individual GP unit was operational - not the actual number of on-off operating cycles.

(13) Total Operating Time - Total time in minutes that each individual unit operated for the twenty-four hour period.

(14) Average Pump Rate - Equivalent to the total daily flow divided by the total operating time. Useful as a gross check of reasonableness, but not a true value due to the fact that total water flow was not equivalent at all times to the total wastewater flow (see Hydraulic Section for more details).

(15) Number of active periods - Total number of active periods (fifteen minute periods) during which at least one GP unit was operational.

(16) Time of Maximum Pressure - The time of day marking the end of that fifteen minute period during which the maximum pressure occurred.

(17) Time of Maximum Flow - The time of day marking the end of that fifteen minute period during which the maximum water flow occurred.

Parameters one (1) through nine (9), sixteen (16) and seventeen (17) were utilized in summarizing the hydraulic characteristics of the pressure sewer project (see Section VII) while the remaining parameters were used in documenting the operational characteristics of the GP units (Section IV).

As for the event recorder, a roll of chart paper lasted approximately eight days. It was then transcribed by research personnel to indicate the actual number of operations per GP unit per day (Figure 27) and the type and number of simultaneous occurrences. The bulk of this information is presented in Section VI of this report.

Conclusions

The demonstration project site proved to be an excellent test site for the GP units. Variations, not only in the population of the individual town houses, but also the day to day life pattern, provided extensive and representative test of the mechanical reliability of the GP units.

The pressure sewer system, particularly the PVC-DWV pipes and fittings, functioned extremely well (Section VII).

The automatic monitoring equipment performed exceptionally well. Following an initial "shakedown" period, there were few interruptions due to electronic components breaking down. The data supplied by the monitoring system coupled with the event recorder information and the day to day operational notes were voluminous but very pertinent to the final evaluation of the GP units.

All of the instrumentation used to record the different parameters worked quite well with the exception of the pressure gages. Clogging of the small diameter copper tubing by the macerated sewage was a constant occurrence and the corrosive effect of sewage on the instrument check valves was extensive. Brass check valves originally used were replaced by stainless steel check valves but the clogging effect was not completely corrected. Therefore, the pressure gaging system was less than 100% operational (see Section VII for more details).

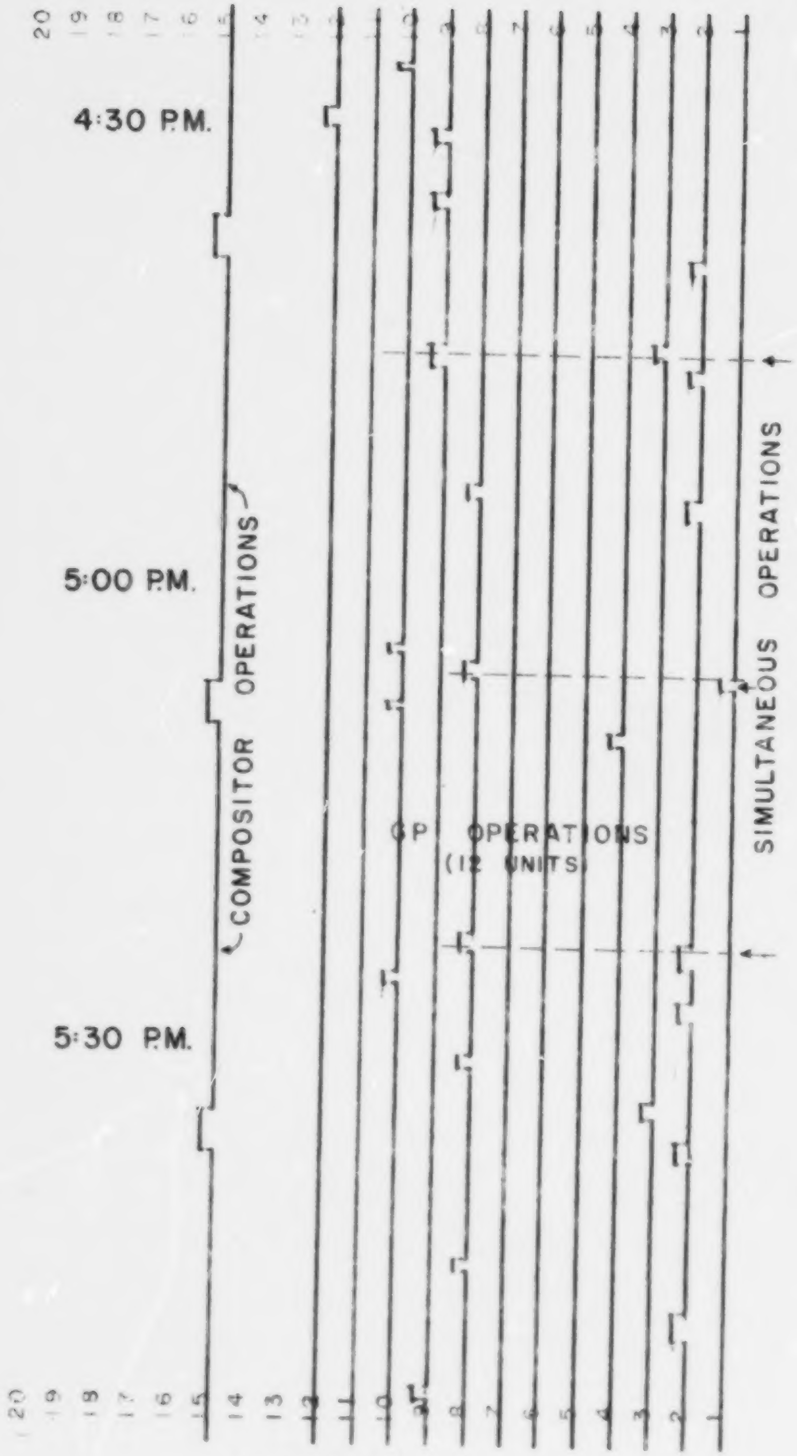


FIGURE 27
EVENT RECORDER STRIP CHART

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SECTION V

THE GRINDER PUMP (GP) UNIT

Introduction

Among the several vital questions to be answered in determining the feasibility of systems of pressure sewers, a paramount one was, "Can a Grinder Pump be developed which performs the necessary functions, is economically feasible, and dependable enough to operate with a high reliability over an acceptably long service life?"

There was some remotely related precedent in the experience with large scale lift stations, ejectors, and force mains. Additionally there are some hydraulic similarities between a water distribution system and a pressure sewer collection system. Major differences include the fact that in one case the fluid is clear, stabilized water, while in the other case the liquid is biologically unstable and contains gross solids of all kinds.

The expertise of a group of knowledgeable civil, sanitary and hydraulic engineers was combined to define the general specifications of a household Grinder Pump. Then, this equipment development task was turned over to a group of product design engineers.

After the specifications were determined and the Grinder Pump equipment designed, built, and laboratory tested, there remained the vital need to prove its hydraulic suitability, solids handling capacity, and operating reliability under actual field conditions over a long enough period of use to yield meaningful conclusions.

The steps leading from basic specifications to a commercially developed, available equipment of demonstrated effectiveness and reliability are the subject of this Section.

Functional Specifications

Basic functional specifications for a household Grinder Pump Unit had been established during the original ASCE Combined Sewer Separation Project. These specifications resulted from extended study by the ASCE project staff, with contributions from the steering committee, and continued to evolve during the prototype development program as a result of inputs from other subcontractor studies which were going on concurrently. The history of this prototype development and the derivation of these specifications has been outlined in considerable detail earlier(9). A few highlights are worthy of quick mention here.

1. Grinder

It had been agreed by the personnel comprising the project staff and steering committee, that any efforts to pump domestic sewage through small diameter pipes would be fruitless unless the solids in wastewater (particularly foreign objects encountered on occasion as a result of carelessness or accident) be reduced to a fine particle size as a first step in the processing. Therefore, the unit included a grinding element operating at 1725 RPM. The location and spacing of the grinder entrance off the bottom of the tank was determined experimentally and its effectiveness in grinding many types of foreign objects such as paper, plastic, fiber, wood, glass, rubber, etc., was thoroughly documented. See Figure 28. During this time it was determined that the placement of the grinder in an inverted position a few inches off the tank bottom dramatically improved its capability of handling foreign objects without jamming. This is of primary importance in a device which must operate with maximum reliability in or near a home for many years.

2. Pump

The pump rate, pressure, discharge size, and required characteristic curve were established prior to the development program as being those required to best match the flow rate, pipe size, power requirements, and hydraulic characteristics into which they would discharge. These requirements were spelled out as necessary inputs to the prototype development program and were based on extensive study by others including L.S. Tucker, who describes the critical necessity for a pump with essentially a vertical head versus discharge (H-Q) curve(12). This same study shows the basic reasons why pumps with centrifugal type characteristic curves will not perform in a system requiring discharge of many units simultaneously into a common header. These conclusions are based on sound hydraulic principles established by Stepanoff and others in various texts on hydraulics, and pump application and design(13,14,15), all of which point out the basic instability of a centrifugal type characteristic (with its flat H-Q curve) when operated in parallel with a number of other pumps, even if they have nominally similar characteristic curves. The problems are accentuated if the centrifugals are of slightly different shaped characteristics, or discharge against different static and/or dynamic heads. These were exactly the conditions which would be obtained in any envisioned large scale pressure sewer system. In such systems each pump would be located at a different position along the line, and would therefore, be required to discharge against a total head composed of static and dynamic components which would vary one from another, and from time to time. This reasoning, based on fundamentals of hydraulics and pump design, dictated the requirement that the H-Q curve for a grinder pump suitable for system use be as nearly vertical as possible. As noted in Figure 29, the pump ultimately chosen is a Moyno Pump, which is positive displacement, progressing cavity type, and has an almost vertical H-Q curve, coupled with proven solids handling ability. Vital in system application is the fact that it does not have a "shut off" head and discharges at an essentially constant rate regardless of head.

The maximum rated operating pressure was somewhat of a compromise between the highest head which might find application in the field and that which could be reasonably obtained with a driving motor whose rating was

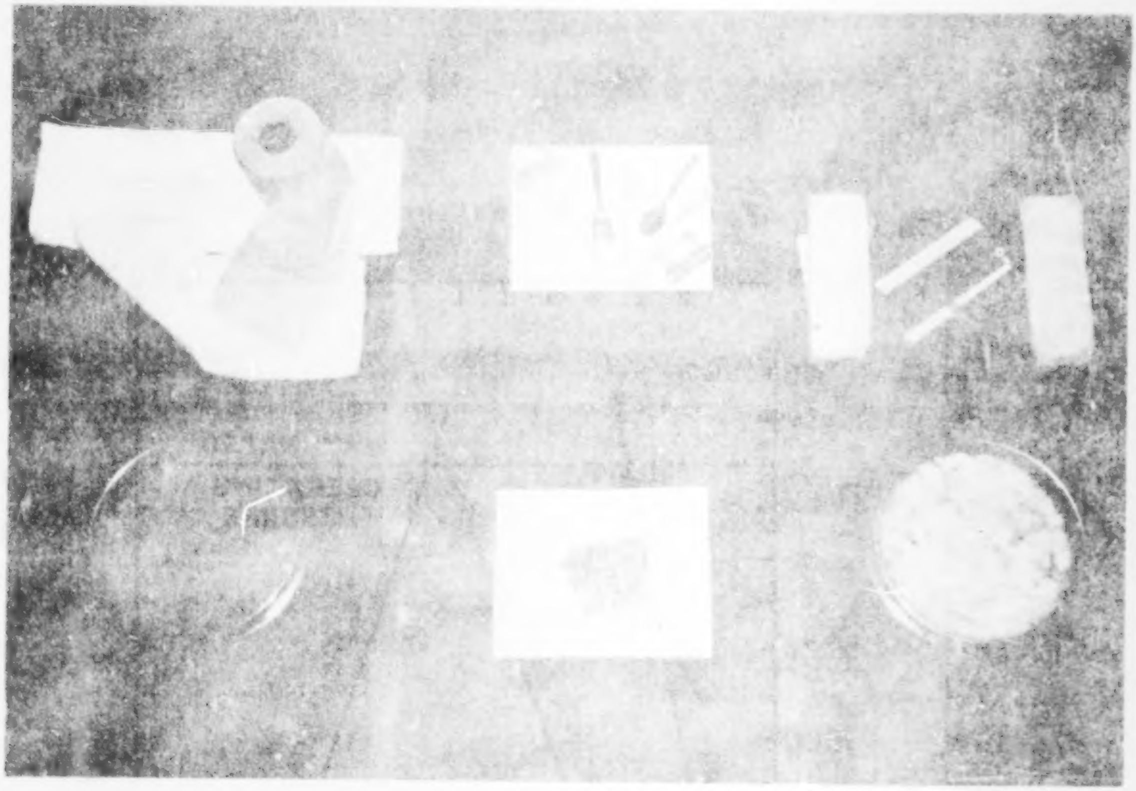
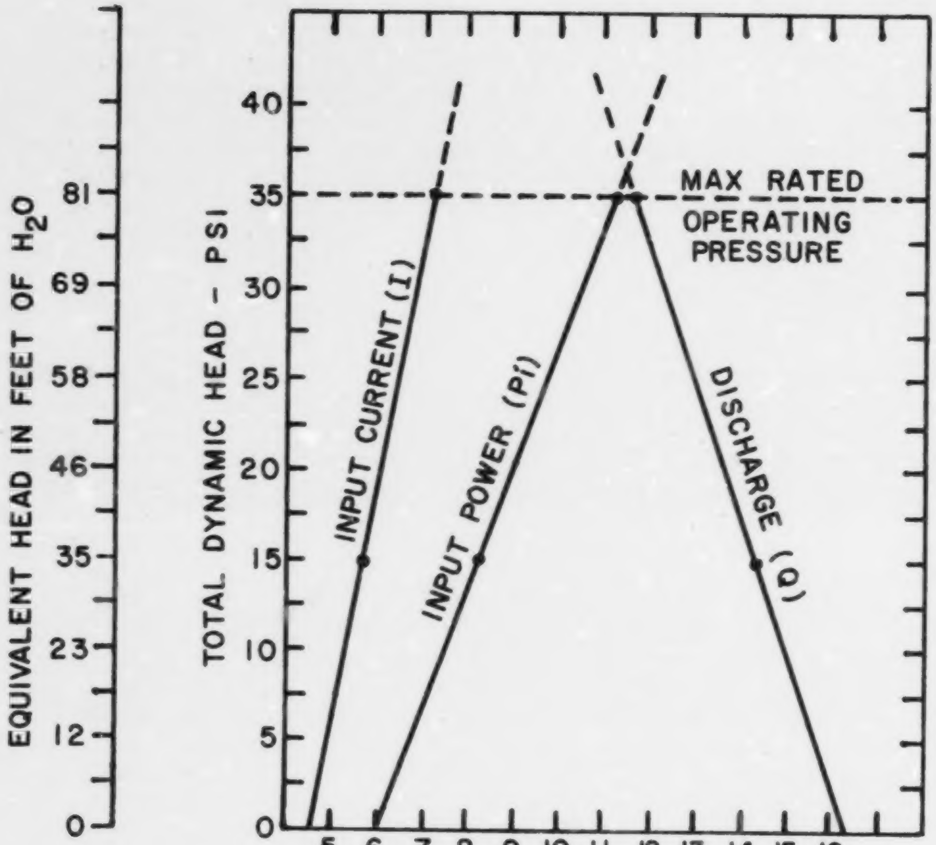


FIGURE 28

BEFORE AND AFTER GRINDING
FOREIGN OBJECTS



Q-GPM, Pi-WATTS X 10^{-2}, I-AMPS AT 240 VAC

TYPICAL PERFORMANCE CHARACTERISTICS OF GRINDER PUMP

FIGURE 29

suitable for connection to residential power circuits. Thus the 35 psig (81 foot H_2O head) rating was chosen. This means that significantly large systems of grinder pump units can be manifolded together into common street sewers, sectionalizing being required only at the ends of reaches which span pressure changes of 35 psig.

3. Size of Discharge Pipe

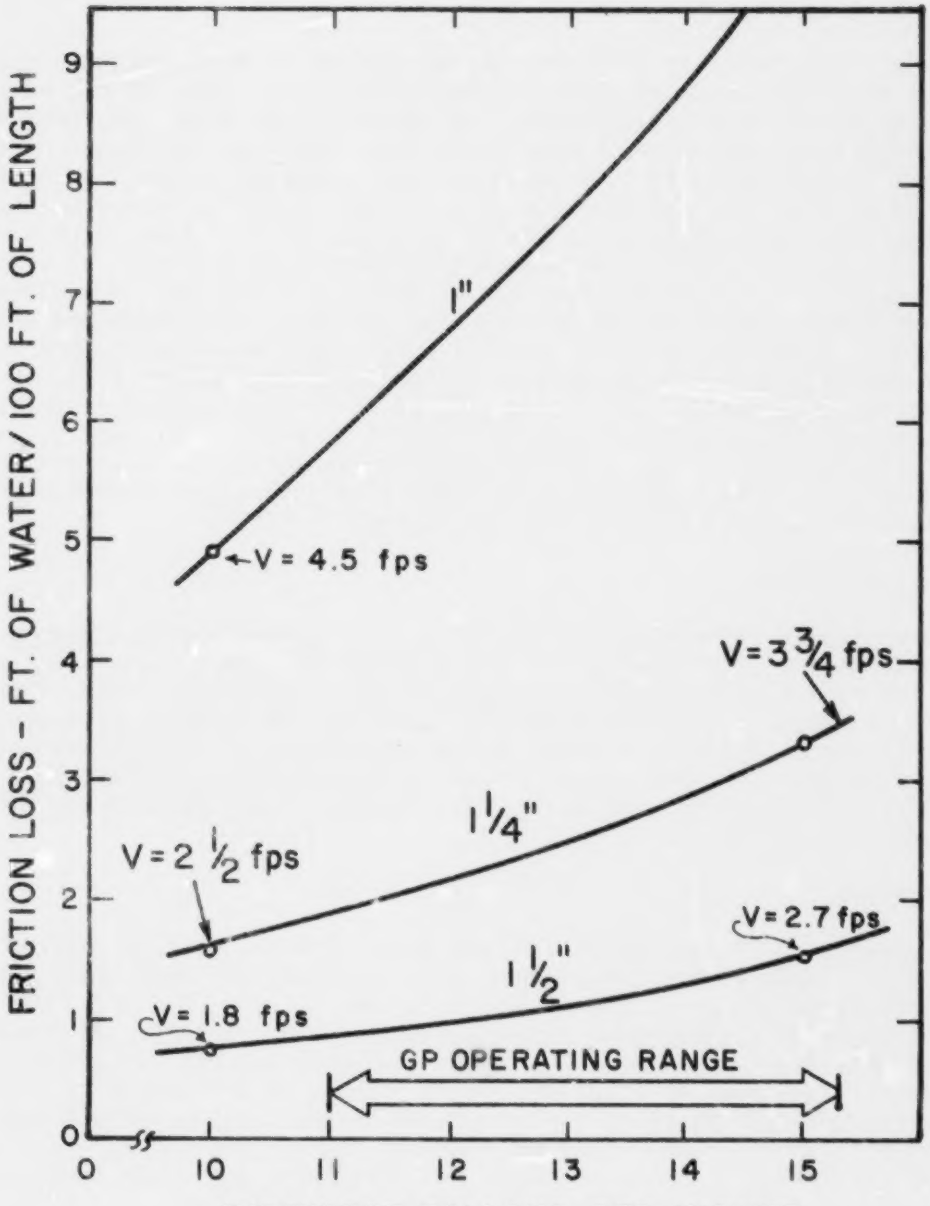
The discharge size of 1¼ inches was determined after preliminary friction loss characteristics of several commonly available sizes of non-metallic pressure pipe were investigated. It was obviously desirable, from the standpoint of economics, simple construction methods, and least disturbance to the environment, to keep the pipe diameter as small as possible, while at the same time insuring it was large enough to convey wastewater reasonably long distances at the anticipated rates of flow without excessive friction loss. The reason for choosing 1¼ inch nominal size is evident from the friction loss curves shown in Figure 30. The nominal pumping rate (which had originally been specified at 10 gpm, and which actually turned out to be between 11 and 16 gpm) was determined in connection with the required tank volume based on studies of household water and wastewater flow rates, some of which were already in the literature and others of which were carried out as part of the ASCE project with the specific purpose of supplying inputs to this product design project. Earlier work leading to these conclusions is documented in publications by Tucker, Waller, and Farrell(16,17,18).

4. Tank Volume

The pump rate along with tank volume must be considered as a system design problem with two parameters, both of which have significant effect on the peak flow handling capability of the combination. This is hydraulically similar to calculation of the magnitude and duration of peaks which can be accommodated by a flood control reservoir. That the tank volume and pump rate were properly selected was confirmed by the fact that no significant overflow occurrences were recorded. For details see Section VI of this report.

5. Motor

The operating characteristics of the motor were essentially that: 1) it be capable of driving a pump with the head-discharge characteristics described above, 2) it provide power for the grinding function, and 3) that it be of a horsepower rating suitable for installation on commonly available residential power circuits. Existing circuit requirements limited this motor to a 1.0 horsepower rating. A low inrush (starting) current and high starting torque were additional requirements to assure reliability and freedom from the nuisance of lamp dimming and TV picture size "shrinkage". Based on these considerations, and after considerable additional development of the grinder to reduce its power requirement, the final motor choice was 1.0 horsepower, capacitor start, high torque, squirrel cage induction motor with a built-in thermal overload protector.



FRICTION LOSS VS DISCHARGE
FOR THREE SIZES OF
POLYETHYLENE PIPE

FIGURE 30

This automatic thermal trip-out avoids possible damage to motor, pipeline, or system, in the event of overloads of any kind. These functions were accomplished with a motor operating at only 1725 RPM. This relatively low speed is very desirable from the point of view of motor life and noise level.

6. Controls

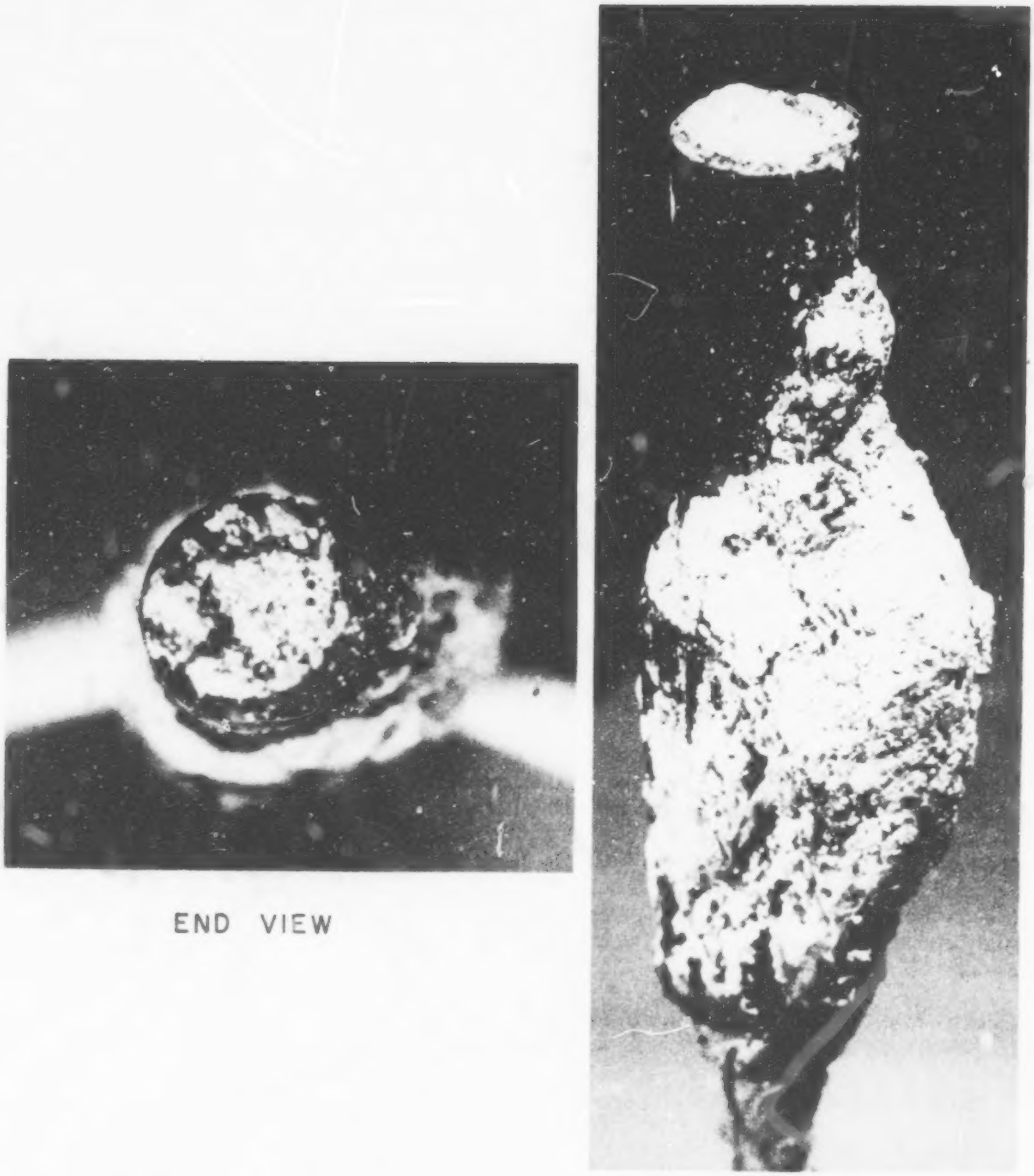
Controls to turn the motor off and on reliably in response to wastewater level in the tank were essential. These must be capable of operating for many years in the "unfriendly" environment of a tank containing raw sewage. Grease is a constituent in most domestic wastewaters which has had a long reputation of being troublesome in this regard. A rather simple system, operating on the principle of an inverted diving bell, was chosen. As the wastewater level rises in the tank, an air column, trapped in the diving bell, is compressed in proportion to the liquid head in the tank. This head generates a pressure which is transmitted to the rugged pressure switch located in the dry portion of the equipment. Initial prototype units employed a diving bell with a 1-inch inside diameter. It was found, through experience in the demonstration project, that this was not free from grease fouling. See Figure 31. As a result of this experience, the diameter of the diving bell was increased to 3 inches. This proved to be a satisfactory permanent solution to the grease fouling problem. See Figure 32. These results are documented elsewhere in this report. The explanation for this is apparently that although grease still tends to accumulate to some degree on the inside walls of the pressure sensing diving bell, before these deposits can completely bridge across and seal the opening, the mass of grease becomes so great that it sluffs off and is therefore self-cleaning. All 12 units in the demonstration project were retro-fitted with these modified larger diameter pressure sensing bells, and the problem was completely eliminated.

A second level sensing control of the same type is provided to indicate an impending overflow condition, thereby providing a warning signal to the owner or operator of the grinder pump. In the demonstration project, such overflows were monitored and reported by the data handling system described in Section IV.

Commercially available production units are normally equipped with a red indicator lamp, but can be arranged to actuate an audible alarm if desired.

7. Check Valve

An integral check valve to prevent any possible backflow of wastewater from the pressure system into the individual grinder pump units was judged from the beginning to be of major importance. Earlier project work(18,19) had shown that no commercially available check valves were suitable for reliable operation in a sewage environment, even though the waste had been ground to a fine slurry. It was, therefore, necessary to develop a unique check valve for this service. It is of the swing check type, and appears rather conventional. Its essential features are rather subtle differences in the shape of passageways (which are smooth and free



END VIEW

SIDE VIEW

FIGURE 31

GREASE FOULING OF 1" DIVING BELL PRESSURE SENSING TUBE USED IN PROTOTYPE GP UNIT

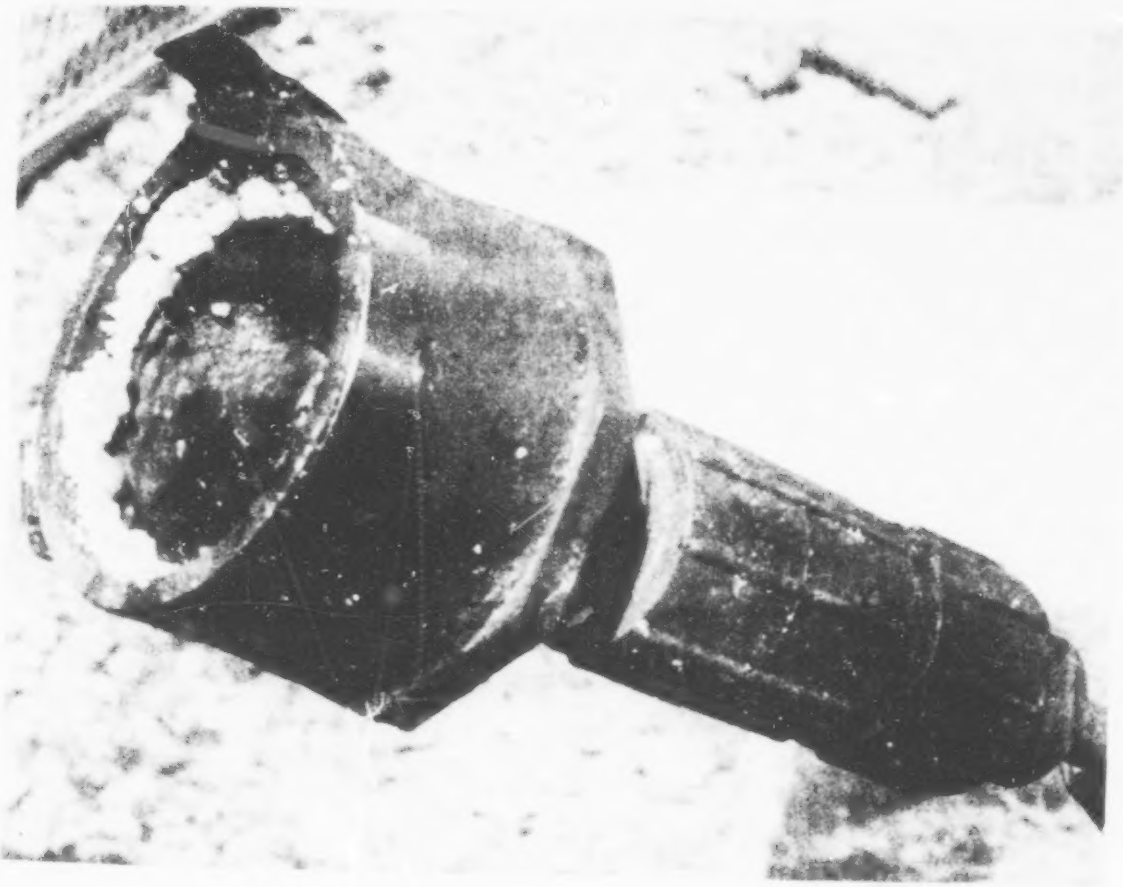


FIGURE 32

MODIFIED 3" PRESSURE SENSING TUBE

from roughness and obstructions) as well as a unique flexible hinge of small section without mechanical pins, rivets, screws, etc. The result is minimum obstruction to flow and no available rough surfaces on which solids can accumulate. Additional protection against catastrophic backflow is provided by the semi-postive displacement pump mentioned earlier, whose construction characteristics are such as to severely limit backflow. This provides an additional factor of safety in the unlikely event of check valve failure. Additionally, manual stop valves were installed in the discharge line near each grinder pump. In future pressure systems, good design practice would seem to suggest the inclusion of a second (redundant) check valve and quarter-turn, full-ported stop valve near the termination of each house connection at the street sewer.

Prototype Model

The above specifications were embodied into the twelve prototype grinder pump units originally installed in this demonstration project and pictured in Figure 33. These prototypes were in general essentially equivalent to that originally developed in ASCE Task 6(9). This design possessed the advantages of meeting the functional specifications, requiring a minimum expenditure for special tooling and design time, and using the maximum number of standard components. It was done to meet a tight timetable, and these prototype units were suitable only for indoor use. The objectives of the prototype phase were to prove the basic feasibility of the idea, and determine if the choice of hydraulic parameters was appropriate.

Production Model

Later, as the demonstration progressed, the Environment/One Corporation continued development of a production model Grinder Pump which was planned to be introduced commercially at a later date. This unit is shown in Figure 34. It was possible to produce a commercially available grinder pump which met the same basic functional specifications outline originally, but was more reliable by at least an order of magnitude as shown by the Section VI data. In addition, the commercial units were considerably more compact, improved in appearance, and able to be handled and installed more efficiently. Beyond this, since it was completely waterproof and corrosion resistant, the commercial grinder pump was also suitable for either indoor or outdoor installation. Ease of service was an important characteristic of the final production design, as was a lower noise level and longer life, particularly of the components subject to corrosion.

While the prototype units cost about $3000 each because they were essentially handmade, production economies enabled the improved commercial design to be offered in quantity for less than $1000 each.

More important than all the preceding was the fact that everything that had been learned from the prototype experience was factored into efforts in the final design to improve reliability and life. As an example, the

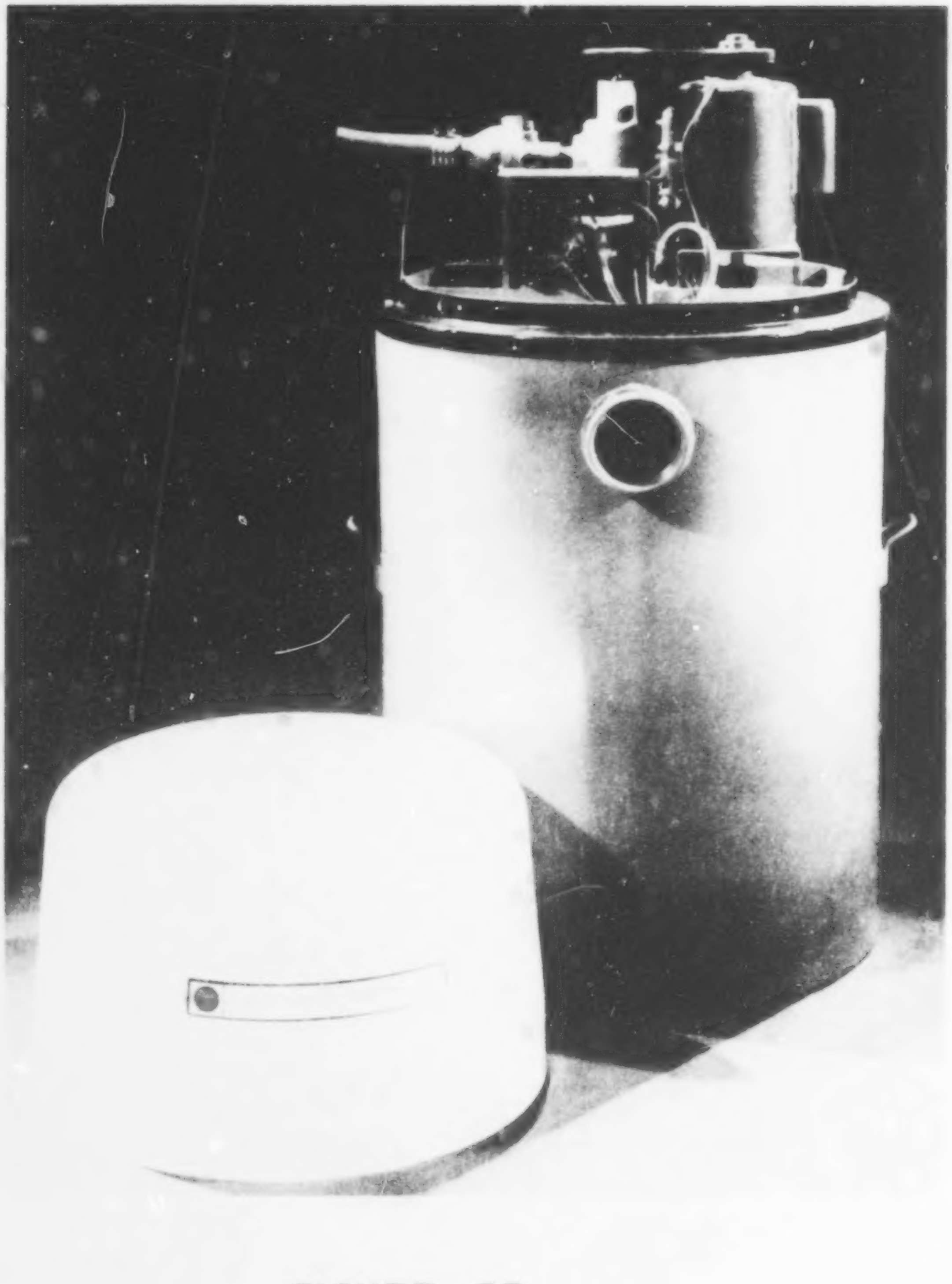


FIGURE 33

PICTURE OF PROTOTYPE MODEL

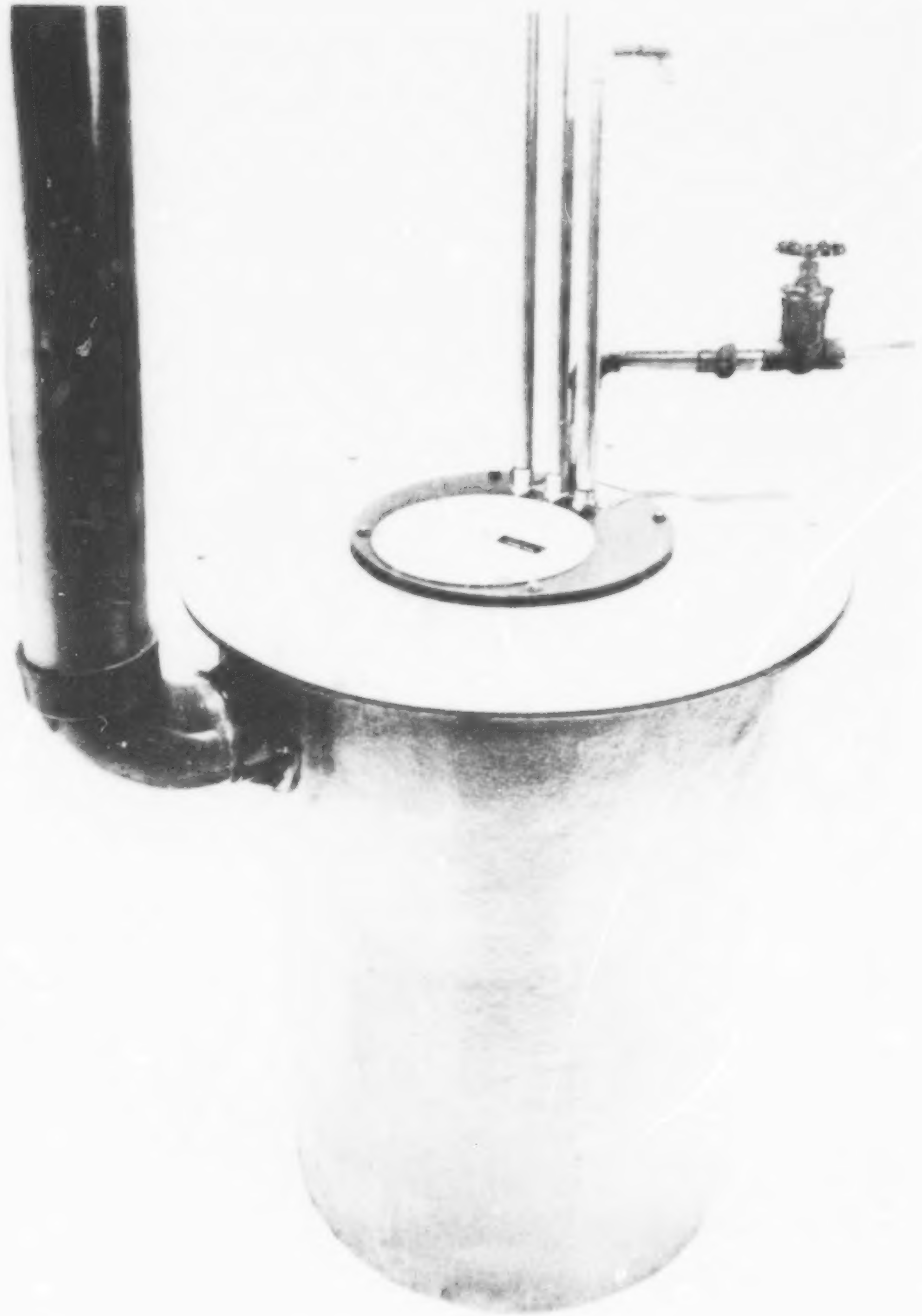


FIGURE 34

MODIFIED GP UNIT (FARRELL 210)

prototype units had the pump mounted on top of the tank, and therefore, subjected to a suction lift requirement of approximately 30 inches each time they started. Although similar pumps had been reported to work satisfactorily under considerably higher suction lifts, this Demonstration Project showed that if a large number of such pumps were called upon to operate under this suction lift condition repeatedly over a long enough period of time, there would be a very small (but in this instance significant) incidence of cases where they would fail to prime. Although this was certainly a low probability which might be considered acceptable in some applications, in a Grinder Pump even this very low failure rate was not considered tolerable. Therefore, the production design was arranged in a different mechanical configuration, assuring that the pump operated with a flooded suction and was, therefore, positively primed each time when called upon to start. This change also eliminated a long shaft, one bearing, and a coupling which had been the source of several failures in the prototypes. Epoxy coated steel tanks, which had been used in prototype units, were replaced by custom-molded fiber glass reinforced polyester (FRP) tanks, a material well known for its combination of high mechanical strength and corrosion resistance, even in wet or below grade applications. As noted in Section VI, this change in tank material offered the additional benefit of a lower noise level, which is especially desirable in indoor installations. The weakness of the level controls on the prototype was eliminated completely by the previously mentioned change to a diving bell of larger diameter, which was not subject to fouling by grease.

By arranging the final unit as a complete one-piece cartridge, servicing was made considerably easier and faster. The complete machinery of the commercially available Grinder Pump Unit is removable as a unit without disturbing the tank, the inlet, or the overflow connection. Thus a new or rebuilt core assembly can be installed, in exchange for a defective unit, in a few minutes, thereby minimizing "downtime" and assuring continuity of service. A core, pulled out of its tank, is illustrated in Figure 35.

Pre-Installation Testing

The mechanical performance of the units was tested prior to their delivery and installation on the job site. This included grinding performance and pump rate versus head for the anticipated range of pressures. Certified pump performance curves for each unit were furnished. Control operating turn-on and turn-off levels, and time delay intervals were recorded. (See Appendix C)

A subjective evaluation of the noise level of each unit was made and recorded. Complete electrical performance was documented, including power and current inputs versus head. To assure electrical safety, all units were tested for insulation resistance, and the standard Underwriter's Laboratories high-potential tests were performed.

The prototype units were recognized by the manufacturer to be the forerunner of a production model which would be more suitable for mass

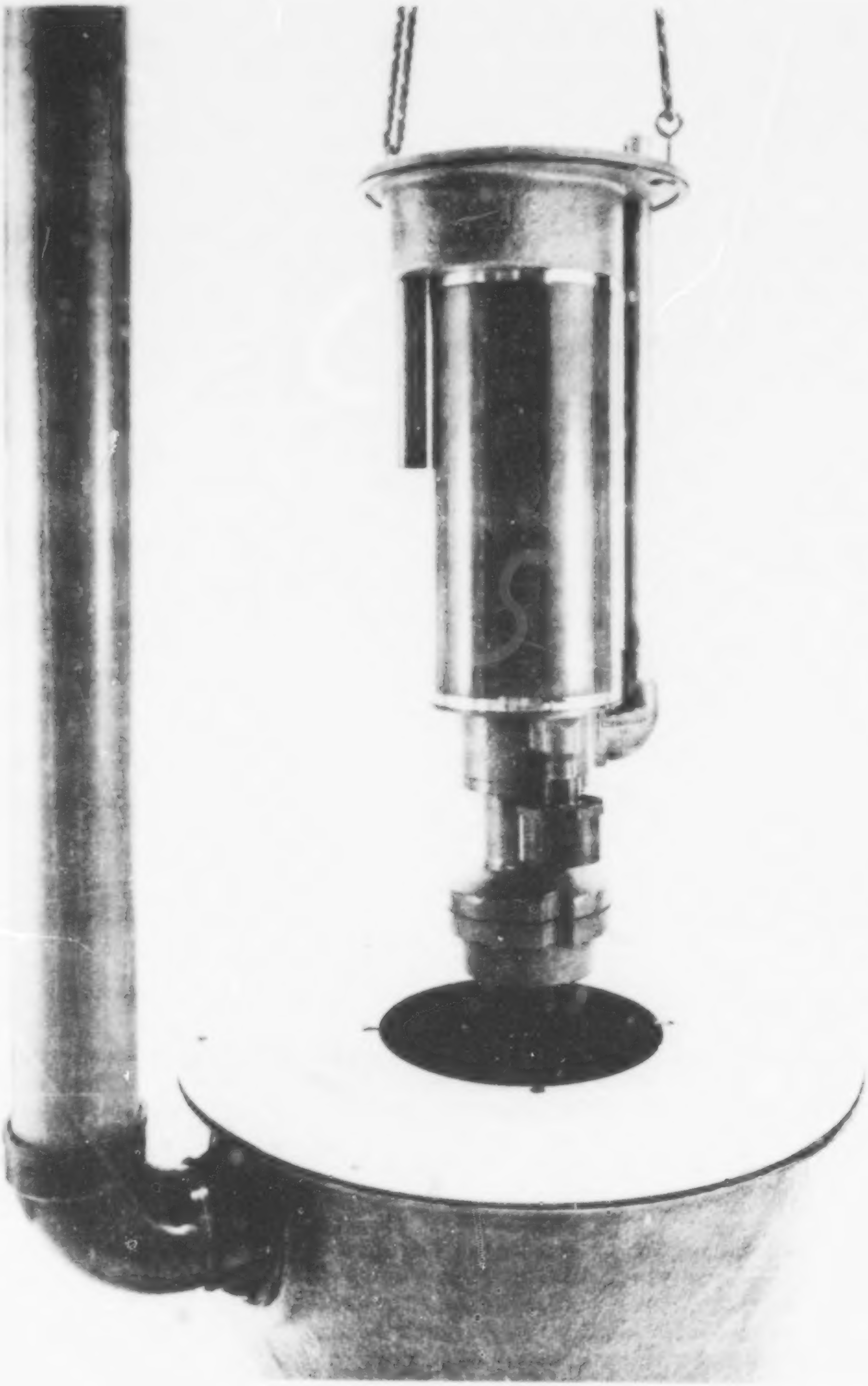


FIGURE 35

CORE REMOVAL IN MODIFIED GP UNIT

production. It was also recognized that the Demonstration Project would be an important proving ground for the fundamental components in the Grinder Pump. With this in mind, care was taken to use the same type of pump, grinder, and size motor that would be used in the production model. The same fundamental level detector and controls were also used. As noted earlier, some of these proved to be unsatisfactory in the early stages of the Demonstration Project. Corrections were incorporated into the production models. A great deal of development testing was done on the grinding mechanism, as this was recognized to be a key element in a successful pressure sewer system.

Installation in Demonstration Project

As described in greater detail in Section IV of this report, these units were installed in a free standing arrangement in the basement of each of a group of 12 town houses. They were plumbed into 1¼" PVC schedule 40 discharge pipe, which passed through the building wall and were connected using DWV fittings into a common pressure main whose size started at 1½" diameter and increased to 3". This choice of 3" mains was made based on the paucity of information available at the beginning of the project concerning the likelihood of simultaneous operation of a number of pumps. As noted in Section IV on Instrumentation, by means of a multi-channel event recorder, the occurrence of simultaneous pump operation in the group of 12 units was accurately recorded for a period in excess of six months. Based on this information, it is now possible to conclude that 4 units out of 12 is the maximum number ever expected to operate simultaneously even on a very infrequent schedule. Consequently, main sizes smaller than 3" would now be recommended for groups of 12 houses. This data point (4 out of 12) has become an important element in the design criteria now available, as a result of this demonstration, for use in sizing pressure street sewers(20). This subject is presented in Table 12 and discussed further in Section VII. While additional refinement is desirable, what is now available provides at least an order of magnitude of improvement over previous knowledge of this subject.

Electrical installation included a 240 volt, single phase, 60 Hz, 3 wire circuit of 10 ampere rating. Special control wiring was also installed to provide for performance monitoring, vital to the data-gathering aspects of the experiment.

Examination of GP Units at End of Project

On Site Testing of Units -

The following items were checked in each unit before it was removed from the home:

(1) Electric power usage from kilowatt-hour meter (Units 1 and 2 only).

(2) "On" time for one complete pump-down cycle.

(3) Turn "On" and turn "Off" levels.

(4) Delay time before turn-on and turn-off.

(5) Noise level (subjective).

Table 3 summarizes these observations and measurements. Explanation of certain items should aid the reader in accurately interpreting these observations.

Noise Level -

No extra steps were taken, during installation, to make the units quiet. Rather they were simply set on the floor without lagging or leveling. During the course of the project, none of the occupants complained of excessive noise. Generally, the modified units were as quiet or quieter than other equipment such as automatic washers, water pumps, and furnace blowers, normally found in the home. As would be expected, the prototype units, with the exposed motor and belt driven pump, were noisiest. The quietest units were the modified units with fiber glass tanks. The modified units with steel tanks were noisier than those with fiber glass tanks.

Laboratory Examination and Testing -

The units were returned to Environment/One Corporation's wastewater engineering laboratory for a more detailed examination of the overall performance and individual parts. These examinations were conducted in November 1971 and within 24 hours after Grinder Pumps were removed from the project site. They were performed jointly by New York State and Environment/One Corporation personnel.

The following measurements and observations were made:

Visual observation of core units
High potential breakdown
Leakage current readings
Evidence of any moisture in motor cavity
Check valve condition
Flow rate vs. pressure
Pump rotor condition
Pump stator condition
Grinding element condition
Seal condition
Observations of tank
Cleanliness of level sensing tubes

In addition, a number of photos were taken of each unit, and are filed with the original data.

Applicable portions of this data are also included in Table 3. Again some explanatory remarks and photos will aid in accurate interpretation of the table.

Table 3

SUMMARY OF OBSERVATIONS AND TESTS OF GRINDER PUMP UNITS AT CONCLUSION OF DEMONSTRATION

Item	Unit Numbers 1	2	3	4	5	6	7	8	9	10	11	12
Operations Counter Reading	11471	5211	11656	7214	5337	1707	6550	7057	9131	8694	3897	8225
kW Hours	154	78	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Exam Controls for Moisture	OK	OK	OK	OK	OK	NA	NA	OK - Grease in Sensor	OK	NA	NA	OK
Timer Operations (Seconds)												
"On" Delay	35.0/36.3	35.7/35.4	33.9/34.8	32.6/33.0	42.1/41.4	NA	29.1/28.9	32.7/37.2	38.5/38.7	33.7/25.0	26.5/27.8	39.1/38.2
"On" Time	54.2/53.6	59.9/59.5	54.9/53.2	51.8/50.4	54.5/51.0	NA	50.6/52.5	71.1/86.5	50.0/49.3	35.7/40.0	31.4/29.3	48.7/48.3
"Off" Delay	30.5/29.6	26.0/25.5	27.2/26.5	26.6/25.9	25.4/24.2	NA	29.7/29.5	27.3/29.7	28.0/28.4	10.4/11.7	----/11.8	25.9/24.9
Check Valve Buble Tight?	No	No	No	No	Yes	Yes	No	No	No	NA	NA	No
Noise Level	Quiet	Slightly Noisy (Loose Parts)	Quiet, but not as low as 1,5,9	Slightly louder than average	Quiet	NA	Louder than Production Model	Quiet, but something vibrating	Quieter than washer or furnace fan	NA	Very noisy - (Bearing Problem)	Very quiet
Level Control Depth in inches												
"ON"	12¼	13	13	13-1/8	12	NA	14-1/8	15¼	13	10½	9-3/4	12-1/2
"OFF"	5¼	7	3½	7	5¼	NA	7-½	4	5	4-3/8	5	5-1/8
Pump Performance GPM/Watts @												
15 psig	14.8/900	14.7/875	14.8/850	14.8/850	14.8/940	14.8/925	14.2/860	14.8/900	15.2/875	15.4/900	14.8/860	14.8/850
25	13.8/1025	13.6/1000	13.6/1000	13.8/925	13.7/1050	13.8/1050	13.8/940	13.8/1025	14.0/1025	14.5/1000	14.0/960	NA
35	12.4/1125	12.2/1125	11.8/1075	12.5/1100	12.4/1100	12.2/1200	12.0/1060	12.4/1150	12.8/1160	13.4/1100	13.2/1060	12.3/1150

NA = Not Available, or not checked

Observation of Core Units -

In general, the core units were remarkably clean. Grease buildup around the turn-on level was the most pronounced place where accumulation of anything occurred as shown by Figure 36. This buildup was heaviest for those units in service longest, and tended to build up where there was a projection or discontinuity in the generally smooth shape of the core. As also demonstrated in Figure 36, the inlet, grinder, and pump areas were very clean (no buildup of anything on working surfaces of inlet, grinders, or pump rotors).

High potential breakdown, leakage current, and moisture in core -

There were no deficiencies or failures in these areas.

Check Valve Condition -

The check valve flappers of the Modified GP units had stringy matter caught in the hinge of the flapper valve and there was a heavy buildup of grease directly behind the flapper (see Figure 37). However, this was not the case for three of the Prototype Models, which were in operation for the duration of the demonstration period (15½ months). These conditions did not interfere with function of the units, but did permit some wastewater to backflow into the tank. This was especially evident when the units were laboratory tested at the conclusion of the project; since most of the check valves would not seal absolutely bubble tight against a two foot column of water. These marked differences in the check valve conditions between the Prototype and Modified GP units can be rather easily justified. While Prototype Model had a horizontal section of pipe immediately following the check valve, the Modified Unit, on the other hand, had a 3 foot vertical pipe section. Therefore, during the non-operational periods, solids settled adjacent to the check valve in the Modified Units causing the excessive accumulations on the flappers. However, it is interesting to note that all evidence points to the fact that the check valves were not leaking a sufficient amount during service to have significant effect on unit performance. Neither the number of unit operations nor unit running times changed significantly during the project. (There was one exception to this -- the check valve on one of the prototypes was replaced during the project because the data on water usage and pump running time did not correlate with what the pump flow rate should have been.)

Flow rate vs. pressure: pump rotor, pump stator, and grinding element condition -

There was no evidence of wear on any of these parts. There has often been expression of concern by prospective users about wear of the grinding elements. These parts exhibited a finely polished appearance only. There was no evidence of wear. This condition is exemplified by Figure 38 (a&b). If pump discharge and power consumption versus head data in Table 3 are compared with these characteristics for a new unit as shown in Figure 29, it is evident that no deterioration of performance occurred during the demonstration.

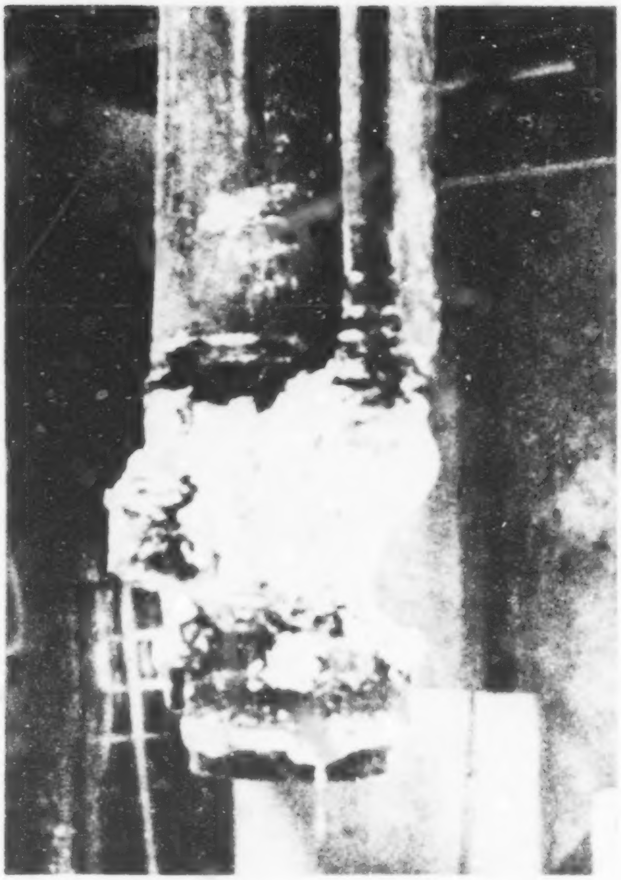


FIGURE 36

PHOTOGRAPH OF GREASE ACCUMULATION AT TURN ON LEVEL - WITH GRINDER RELATIVELY CLEAN

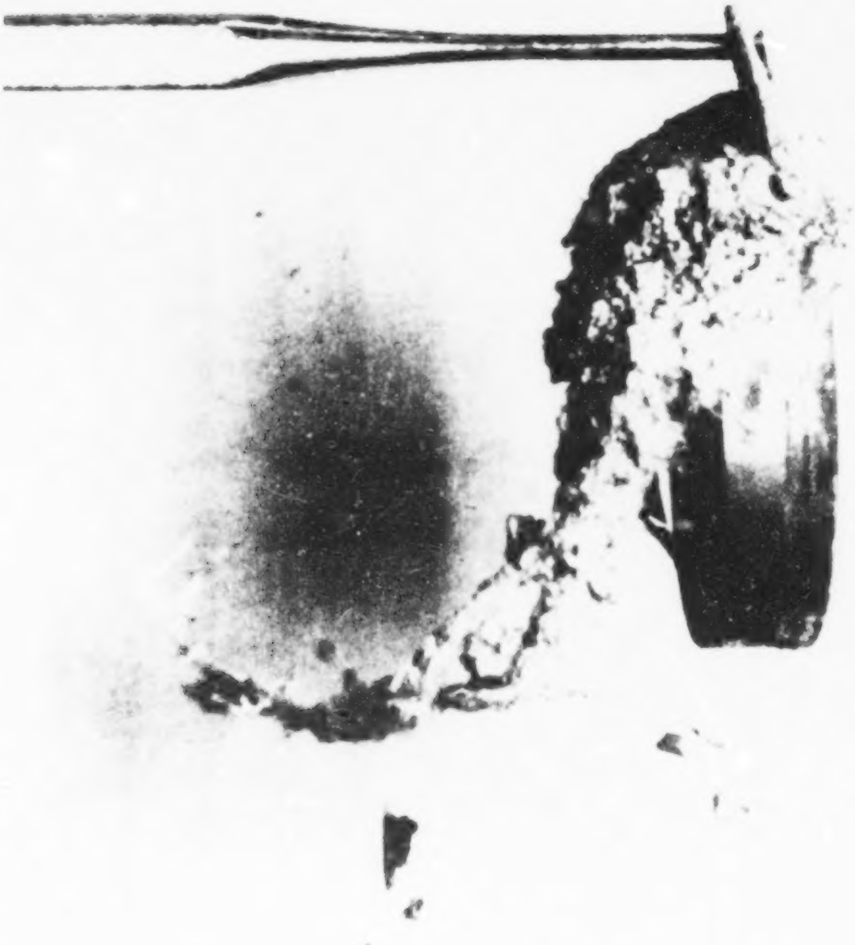


FIGURE 37

PHOTOGRAPH OF SWING VALVE FLAPPER

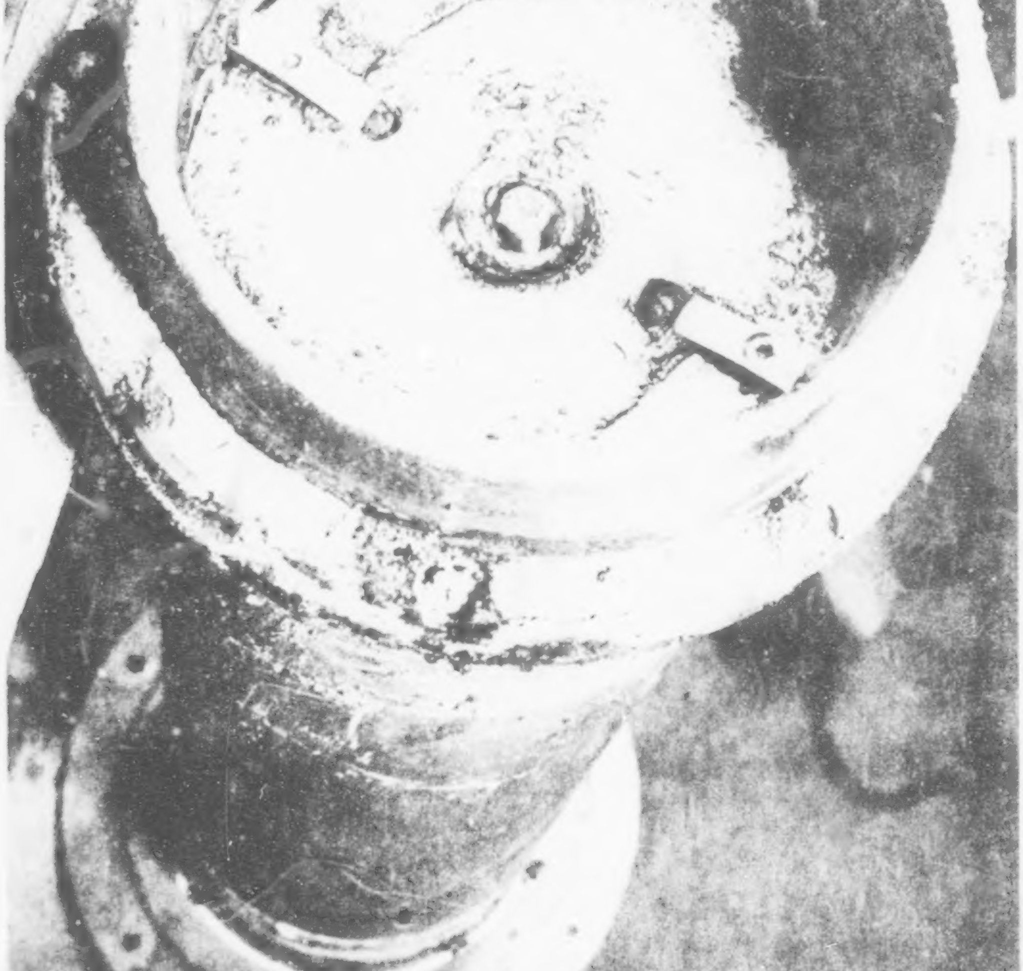


FIGURE 38A

GRINDING ELEMENT

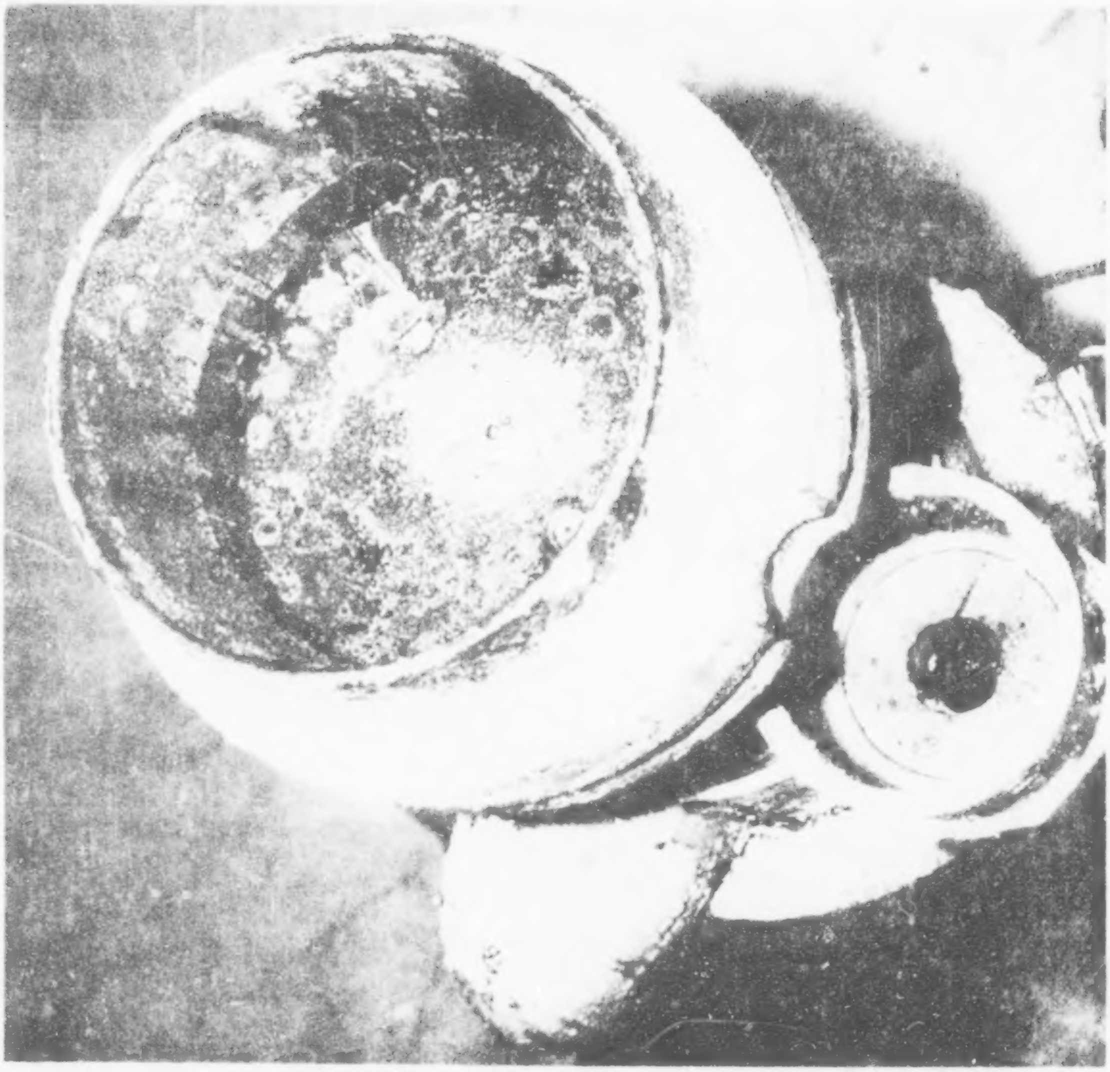


FIGURE 38B

GRINDING ELEMENT AND
BELL SHAPED PRESSURE SENSOR

Seal Condition -

Most seals were very clean. Some did have stringy material caught in the stainless steel coil spring but this apparently did not interfere with proper function as evidenced by the absence of moisture in the core interiors and no evidence of electrical insulation breakdown.

Observations of tanks -

There was a grease buildup on the side of almost all tanks. This buildup was centered around the turn-on turn-off levels, and in some cases, extended out from the tank wall as much as five inches. This did not appear to interfere with proper operation (except for its effect on tank holding volume). Typical buildup on a steel tank is shown in Figure 39, while a typical fiber glass tank is pictured in Figure 40.

Two additional observations are interesting, namely that 1) the buildups in both tanks are interrupted immediately under the inlet connection where the in-flowing wastewater washes the wall clean, and 2) the size of buildup on fiber glass tanks is much smaller, evidently because of its very smooth interior finish.

The steel tanks in general appeared to be unsatisfactory for long term use in the intended service since all were rusting badly. (There is a *possibility* that a better protective coating on the steel *might* overcome this drawback.) The fiber glass reinforced polyester tanks appeared to be totally satisfactory for this use. After rinsing them out there was no evidence of attack of any kind. Table 4 gives further data on tanks.

Cleanliness of level sensing tubes -

All of the units had been retrofitted during the demonstration with 3" diameter diving bells on the main level sensor tube. Without exception these were operational at conclusion of test. Most were completely clean, and a few had some slight grease buildup, as much as 1" high in the tube, but this had no detrimental effect on operation or calibration of the level controlled switch. A bottom view of the tube from Unit #4 has already been presented in Figure 32. One inch diameter tubes were used for the overflow sensors, and these were all clean and operational. It should be noted that since they are high in the tank, they become submerged very infrequently and thus are much less exposed to grease.

Conclusions

1. Functional specifications for a household grinder pump unit as originally defined during ASCE's Combined Sewer Separation Project were met, and demonstrated to be appropriate.
2. Performance of the original prototypes, though functionally and hydraulically correct, was unacceptable in terms of reliability.

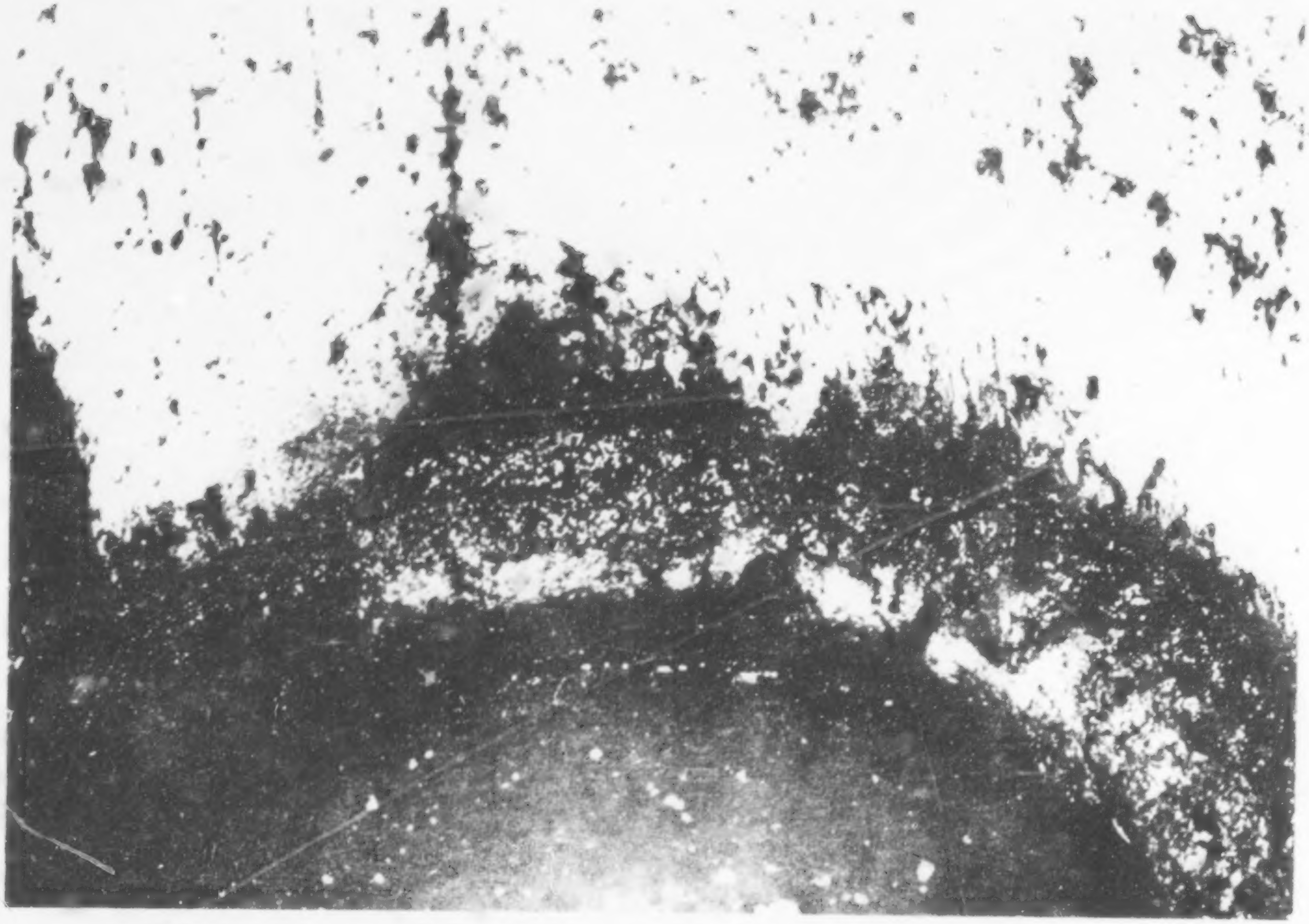


FIGURE 39

TYPICAL GREASE ACCUMULATION IN STEEL TANK

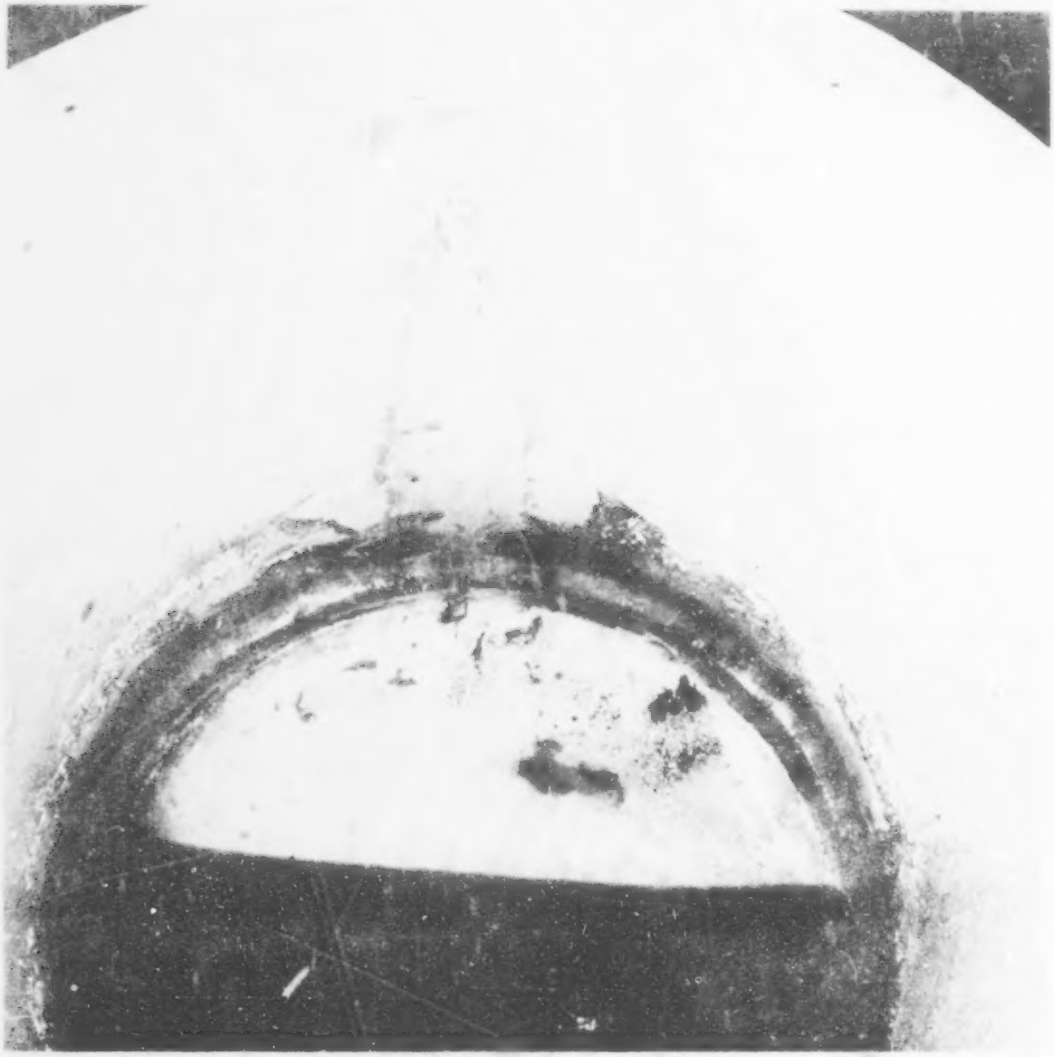


FIGURE 40

TYPICAL GREASE ACCUMULATION
IN FIBER GLASS TANK

Table 4

DESCRIPTION OF UNITS AT END OF TEST

Item / Unit #	1	2	3	4	5	6	7	8	9	10	11	12
Type Unit Note 1)	GP210 COMM.	GP209 COMM.	GP209 COMM.	GP209 COMM.	GP210 COMM.	GP210 COMM.	GP200 PROTO	GP209 COMM.	GP209 COMM.	GP200 PROTO	GP200 PROTO	GP209 COMM.
Tank Material (Note 2)	FRP	STEEL	STEEL	STEEL	FRP	FRP	FRP*	FRP*	FRP*	FRP*	FRP*	FRP*
Tank Finish	MOLD-ED IN	EPOXY PAINT	EPOXY PAINT	EPOXY PAINT	MOLD-ED IN	MOLD-ED IN	MOLD-ED IN	MOLD-ED IN	MOLD-ED IN	MOLD-ED IN	MOLD-ED IN	MOLD-ED IN
Tank Diameter (in Inches)	26top 24bot	28	28	28	26top 24bot	26top 24bot	26top 24bot	26top 24bot	26top 24bot	26top 24bot	26top 24bot	26top 24bot
Tank Height in Inches	36	36	36	36	36	36	36	36	36	36	36	36
Peak Flow Storage Volume, in Gallons (Note 3)	30	43	43	43	30	30	43	30	30	43	43	30

NOTES - 1) GP210 = Commercially available Model Farrell 210 by Environment/One Corp.
GP209 = Commercially available Model Farrell 209 (core only)
GP200 = Prototype Model Farrell 200, no longer commercially available.

2) FRP = Fiberglass Reinforced Polyester - Supplied by Environment/One Corp.
FRP = Fiberglass Reinforced Polyester - Supplied by Local Manufacturer

3) Peakflow Storage = Volume above turn "on" level and below overflow

3. A modified commercial unit was developed which successfully met the functional specifications, was approximately an order of magnitude more reliable than the prototypes, and possessed a number of additional features such as quieter, and more compact, which broadened its potential area of application.

4. The necessity for pumps which are positively primed, and protected from accidental siphoning, was demonstrated by the difference in operating experience between the prototype and modified commercial grinder pump units.

5. The necessity for constant displacement pumps, in a system with variable and widely fluctuating heads, already brought out in earlier work of a more fundamental nature, was demonstrated in a very practical way. Centrifugal type pumps can be used only on an individual basis. In order for such pumps to function in pressure sewer systems, they must be equipped with pressure regulating flow control devices, and/or variable speed automatically controlled motors, neither of which is a practical alternative for the small scale required by units for use in systems serving residences and similar small buildings.

6. Epoxy coated steel tanks proved to be unsatisfactory since all six were rusting badly. The possibility of a better protective coating might improve their performance. However, the fiber glass reinforced polyester tanks appeared to be much more practical, not only because of their lightness in weight but also because of the lack of any deterioration signs after being exposed to raw sewage for over 15 months.

7. Like any electro-mechanical device, the grinder pump will require occasional minor repair, and very infrequent major overhaul. This fact has been a strong factor in the design of the modified units, so that speedy replacement by semi-skilled personnel can be carried out using a core exchange technique which will insure minimum "downtime".

8. It appears that this fifteen-month long practical field demonstration, coupled with other knowledge already available or accumulated by others concurrently, has proven the suitability of the pressure sewer approach as a workable solution to many of those situations where conventional gravity sewers are technically or economically not feasible. In addition, several significant data points were obtained which coupled with the hydraulic information already available from other sources, provide the basic criteria for the design of large scale pressure sewer systems. Therefore, properly designed pressure sewer systems should find increasing application in those special situations with problems which outweigh the advantages of conventional gravity systems in more normal circumstances.

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SECTION VI

SUMMARY OF OPERATIONAL DATA

Introduction and Objectives

This section focused its attention on five specific objectives which were explicitly stated in the approved grant application(11).

"..........2. Obtain the operating experience necessary for an evaluation of the effectiveness of the individual pump-storage-grinder (GP) units by subjecting these prototypes to an extended period of actual use in a significant number of homes where the mechanical performance, use patterns, operating costs and maintenance requirements are completely monitored."

"3. Through the monitoring program mentioned, determine the occurrence and duration of any overflows to the gravity sewers which may take place. This information will either confirm the initial choice of pump rate and reservoir capacity or show the need for future optimization".

The mechanical performance of the individual GP units is perhaps the single most important parameter to be evaluated(2). This evaluation was made utilizing the extensive data supplied by the automatic monitoring equipment, event recorder's charts, and recorded field observations described in detail in Section IV.

The same data also furnishes information on use patterns, operating costs, and maintenance requirements necessary for the design of future systems.

Results - Mechanical Performance

A bar graph was prepared showing the performance of the twelve GP units, the automatic monitoring system, and the event recorder (Figure 41). It should be noted that, for the duration of the field demonstration, the event recorder and monitoring equipment were never out of operation at the same time. As a result, a relatively continuous monitoring of the pressure sewer system was obtained.

The total number of operations was recorded by the twelve channel event recorder. Prior to its installation on January 4, 1971, unit counters, which were part of the automatic monitoring equipment, had to be read manually and they, at best, could give us only the total number of operations over longer periods of time, such as twenty-four hours.

The information gathered by the event recorder was transcribed manually to yield the total number of operations over any fifteen minute period for any given day, with simultaneous operations also being tabulated at the same time.

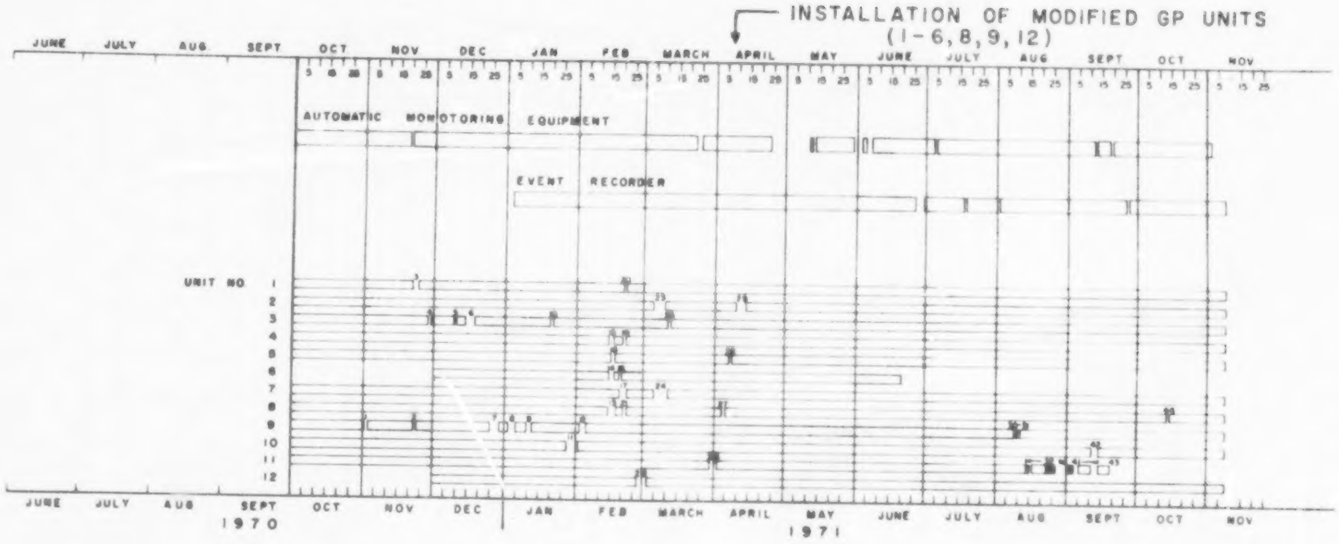


FIGURE 41

PERFORMANCE RECORD OF GP UNITS
AND MONITORING EQUIPMENT

The total number of on-off operations as reported in Table 5 reflects those operations from October 1, 1970 to the termination of the project, November 7, 1971, a thirteen month period. However, some units were in operation prior to the official starting date during the so-called debugging period.

Therefore, it should be noted that, in addition to the operations reported in Table 5, there was a total of 6,282 operations for the months of August and September, 1970. This total is distributed as follows for the twelve units:

Unit #	1	2	3	4	5	6	7	8	9	10	11	12
Operations	722	366	1064	431	888	0	203	184	1112	674	513	125

The 125 operations reported for Unit No. 12 were due to the fact that the developer allowed the usage of the sanitary facilities by the project's personnel. This same unit was reported as being unoccupied until December 1970.

Two much more informative tables (Tables 6 and 7) report the total number of operations both for the prototype and the newer, modified units. This separation is essential for the evaluation of the overall mechanical performance of the newer units.

The total motor running time was listed on the daily computer summary sheet. Depending on the size and type of tank, the average running time per cycle varied for each unit as shown in Table 8. Again, separation was desirable in order to differentiate between the operating cycles for the prototype and modified GP units.

In the previous chapter, the exact length of the motor running cycle for each of the twelve units was reported, as it was measured at the termination of the demonstration while the GP units were still in place.

By taking the average daily operations and multiplying this value by the length for each operation, an average daily operating time is obtained for each of the town houses (Table 9). As can be seen, the average daily operating time varied greatly for the 12 GP units.

The variation in the above values is dependent on a number of factors, such as: population, wastewater flows, final pressure sensing tube and pressure switch adjustments, etc.

As to the number and type of malfunctions, we encountered a total of 44 individual malfunctions within the GP units' system, excluding malfunctions of the research monitoring equipment

The bar graph (Figure 41) has these malfunctions enumerated and Appendix D describes each occurrence. Basically, all of the 44 malfunctions can be placed into four specific categories:

TABLE 5 - TOTAL NUMBER OF OPERATIONS

Unit No. Mo/Yr	1	2	3	4	5	6	7	8	9	10	11	12	Total per Month
Oct. 70	1097	313	500	383	353	-	393	295	552	332	243	-	4,461
Nov. 70	753	283	509	342	369	-	372	347	575	303	242	-	4,095
Dec. 70	578	295	588	253	380	243	307	350	455	306	201	711	4,667
Jan. 71	993	279	925	456	381	214	359	338	466	250	191	777	5,629
Feb. 71	640	273	818	333	281	198	240	249	422	593	109	601	4,756
Mar. 71	523	264	972	599	299	290	282	701	546	592	124	933	6,125
Apr. 71	399	293	502	394	365	382	383	418	422	551	274	483	4,866
May 71	690	512	524	420	211	209	499	447	525	666	358	604	5,665
June 71	1154	444	493	313	401	-	440	571	577	719	284	600	5,996
July 71	993	483	539	288	295	-	559	828	530	686	370	666	6,237
Aug. 71	886	420	716	599	329	-	487	845	607	775	168	607	6,439
Sept 71	568	366	840	775	238	-	534	735	851	512	226	658	6,303
Oct. 71	950	523	842	761	428	-	814	516	840	500	-	602	6,776
Nov. 71	209	100	166	133	128	-	179	78	168	122	-	160	1,443
Total per Unit	10,433	4848	8934	6049	4458	1535	5848	6718	7536	6906	2790	7402	73,458 Total per project

Average Operations = 2.6 per capita per day

TABLE 6 TOTAL NUMBER OF OPERATIONS FOR PROTOTYPE GP UNITS

Unit No. Mo/Yr	1	2	3	4	5	6	7	8	9	10	11	12
Oct. 70	1,097	313	500	383	353	-	393	295	552	332	243	-
Nov. 70	753	283	509	342	369	-	372	347	575	302	242	-
Dec. 70	578	295	588	253	380	243	307	350	455	306	201	711
Jan. 71	993	279	925	456	381	214	359	338	466	250	191	777
Feb. 71	640	273	818	333	281	197	240	249	422	593	109	601
Mar. 71	433	240	866	599	299	290	282	701	531	592	124	926
Apr. 71	-	-	-	11	78	10	383	69	-	551	274	-
May 71	-	-	-	-	-	-	499	-	-	666	358	-
June 71	-	-	-	-	-	-	440	-	-	719	284	-
July 71	-	-	-	-	-	-	559	-	-	686	370	-
Aug. 71	-	-	-	-	-	-	487	-	-	775	168	-
Sept. 71	-	-	-	-	-	-	534	-	-	512	226	-
Oct. 71	-	-	-	-	-	-	814	-	-	500	-	-
Nov. 71	-	-	-	-	-	-	179	-	-	122	-	-
Total per Unit	4,494	1,683	4,206	2,377	2,141	954	5,848	2,349	3,001	6,906	2,790	3,015

TABLE 7 NO. OF OPERATIONS FOR MODIFIED GP UNITS

Unit No. Mo/Yr	1	2	3	4	5	6	7	8	9	10	11	12
Oct. 70	-	-	-	-	-	-	-	-	-	-	-	-
Nov. 70	-	-	-	-	-	-	-	-	-	-	-	-
Dec. 70	-	-	-	-	-	-	-	-	-	-	-	-
Jan. 71	-	-	-	-	-	-	-	-	-	-	-	-
Feb. 71	-	-	-	-	-	-	-	-	-	-	-	-
Mar. 71	90	24	106	-	-	-	-	-	15	-	-	7
Apr. 71	399	293	502	383	287	372	-	349	422	-	-	483
May 71	690	512	524	420	211	209	-	447	525	-	-	604
June 71	1154	444	493	313	401	-	-	571	577	-	-	600
July 71	993	483	539	288	295	-	-	828	530	-	-	666
Aug. 71	886	420	716	599	329	-	-	845	607	-	-	607
Sept. 71	568	366	840	775	238	-	-	735	851	-	-	658
Oct. 71	950	523	842	761	428	-	-	516	840	-	-	602
Nov. 71	209	100	166	133	128	-	-	78	168	-	-	160
Total per Unit	5,939	3,165	4,728	3,672	2,317	581	0	4,369	4,535	0	0	4,387

TABLE 8

LENGTH OF OPERATING CYCLE
AVERAGE TIME (SEC)

TYPE OF GP UNIT / UNIT NUMBER	PROTOTYPE	MODIFIED
1	58	59
2	74	71
3	39	74
4	56	59
5	77	69
6	111	65
7	63	(55)*
8	93	57
9	38	67
10	41	(39)*
11	112	(40)*
12	43	68

*PROTOTYPE GP UNITS WITH NEW TIMERS AND PRESSURE GAGES

TABLE 9

AVERAGE OPERATING TIME FOR GP UNITS PER DAY

Unit No.	Operating Time (min.)
1	28.5
2	16.0
3	35.2
4	17.0
5	13.6
6	13.9
7	13.0
8	16.8
9	20.3
10	11.1
11	8.7
12	20.5

A - Unit's Motor Continuously Running

This was caused primarily by two factors; first, the pump losing its prime and secondly, by an irregularity within the pressure sensing tube. The pressure within the sensing tube would build up, activating the unit but recurring grease accumulations would block the 1" orifice, thereby not permitting the pressure to be released when the wastewater level was pumped down. Also, an occasional faulty pressure switch accounted for the occurrence of this malfunction.

B - Excessive Noise Within a GP unit

This occurred only during the prototype phase. The major reasons were the loosening of pulleys causing excessive vibrations, and the motor's belt rubbing against the metal guard.

C - Unit in Overflow Condition

Caused primarily by the accumulation of grease within the one inch bell shaped pressure sensing tube. This built up, completely clogged the one inch opening, and did not permit the normal registration of the increasing wastewater level within the tank. Therefore, without an increase of pressure within the bell shaped tube, the GP units did not operate and the overflow system was activated. In addition, an occasional faulty pressure switch, or an on-delay timer activated the overflow condition.

D - Improper Functioning of the GP Unit

That portion of the malfunctions dealing with this topic was again caused by faulty on-delay timers and pressure switches.

Out of the 44 malfunctions recorded, Category "A" accounted for half or 22 of the total number, followed by Category "C" with 14, Category "B" and "D" with 4 each.

In the second phase of the demonstration project, only 5 malfunctions were recorded for the new and modified units. These five were covered by Categories "A" and "D" only.

By closely examining the different types of malfunctions, only the negative side of the picture is being presented. It is, therefore, essential to dwell for some time on the positive side of the mechanical performance of the GP units.

In order to do this, a method of expressing the overall mechanical performance or operating status of the GP units by means of a single numerical value seemed desirable.

A value selected was tabbed as the Project's Operation Ratio. It is equivalent to:

$$\text{O.R.} = \frac{\text{Number of GP Unit Day of Actual Operation}}{\text{Total Number of GP Unit Days of Possible Operation}}$$

Table 10 reports the results of the monthly Operation Ratios and the Overall Operation Ratio for the Demonstration Project. A very important note is the fact that the numerator value excludes those days when any of the GP units were out of operation for a period of time greater than 15 minutes.

In order to evaluate the performance of the modified units, a separate table of operation ratios was prepared (Table 11). These same values can be found in the previous table but an overall operation ratio was computed based only on the nine new GP units.

Use Pattern

As was expected, the average usage pattern of the GP units varied greatly. This was anticipated since the number of people living within each of the town houses also varied from a low occupancy rate of three persons per unit to a high rate of eleven persons per unit. Figure 42 reports the occupancy rate for each of the twelve units.

In order to show the variability in the GP unit's usage, the daily average GP operations were calculated on a monthly basis, accompanied by their respective high and low values. These values are presented in Table 12.

By using the event recorder data, daily cumulative GP unit operations' diagrams were constructed for some typical housing units. These diagrams (Figures 43 and 44) are meant to illustrate the usage pattern over a typical twenty-four hour period. Weekend patterns are somewhat different, as would be expected, with the total number of operations for the entire demonstration project increasing by as much as 80 over any given weekday total (Figure 45).

Operating Cost

This parameter deals explicitly with the annual cost of electric energy for the operation of the GP units. Table 13 reports a theoretical cost of \$2.12/year(9).

In order to verify this theoretically derived value, two watt-hour meters were installed in Town Houses Nos. 1 and 2 as previously reported. Unit No. 1 registered a total of 154 KW hours while Unit No. 2 accounted for 78 KW hours. These values represent the total electrical power consumption over a fifteen month period (thirteen months for the actual demonstration period and two months for the de-bugging period).

Then, the average monthly power consumption for these two GP units was calculated to be 10.2 and 5.3 KW hours respectively. Applying an average incremental power consumption rate of 2.3¢ per Kilowatt-hour (KWH)(21), the operational monthly cost for Unit No. 1 amounted to \$0.23 and \$0.12 for Unit No. 2.

Both GP units had a somewhat identical operational cycle. Therefore, the differential in the operational cost for the two units can be accounted

TABLE 10 - SUMMARY OF OPERATION RATIOS

Unit No. Mo	1	2	3	4	5	6	7	8	9	10	11	12	Project Operation Ratio	Project Operation Ratio*
Oct	1.00	1.00	1.00	1.00	1.00	.00	1.00	1.00	1.00	1.00	1.00	.00	0.83	1.00
Nov	.90	1.00	.97	1.00	1.00	.00	1.00	1.00	.87	1.00	1.00	.00	0.81	.97
Dec	1.00	1.00	.84	1.00	1.00	1.00	1.00	1.00	.81	1.00	1.00	1.00	0.97	.97
Jan	1.00	1.00	.94	1.00	1.00	1.00	1.00	1.00	.77	.84	1.00	1.00	0.96	.96
Feb	.86	1.00	1.00	.86	.93	.82	.82	.79	.89	.96	1.00	.93	0.90	.90
Mar	1.00	.81	1.00	1.00	1.00	1.00	.77	1.00	1.00	1.00	.94	.94	0.95	.95
Apr	1.00	.83	1.00	1.00	.97	1.00	1.00	.93	1.00	1.00	.97	1.00	0.97	.97
May	1.00	1.00	1.00	1.00	1.00	.45	1.00	1.00	1.00	1.00	1.00	1.00	0.95	1.00
June	1.00	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00	1.00	1.00	0.92	1.00
July	1.00	1.00	1.00	1.00	1.00	-	1.00	1.--	1.00	1.00	1.00	1.00	0.92	1.00
Aug	1.00	1.00	1.00	1.00	1.00	-	1.00	1.00	.94	1.00	.61	1.00	0.88	.96
Sept	1.00	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	.87	.58***	1.00	0.85	.96
Oct	1.00	1.00	1.00	1.00	1.00	-	1.00	.97	1.00	1.00	-	1.00	0.83	.996
Nov.	1.00	1.00	1.00	1.00	1.00	-	1.00	1.00	1.00	1.00	-	1.00	0.83	1.00
O.R. per Unit	.98	.97	.98	.99	.99	.40** .97	.97	.98	.95	.98	.82 .94	.84** .99	0.90	

* This ratio excludes those units which were unoccupied but where the GP Unit was operational.

** First ratio is based on entire demonstration period, while second ratio is based during period of occupancy.

***Prototype Unit was removed from service because of numerous malfunctions, as of Sept. 19, 1971.

TABLE 11 - SUMMARY OF OPERATION RATIO FOR MODIFIED UNITS

Unit No. Mo	1	2	3	4	5	6	7	8	9	10	11	12	Operation Ratio
Oct	-	-	-	-	-	-	P	-	-	P	P	-	
Nov	-	-	-	-	-	-	R	-	-	R	R	-	
Dec	-	-	-	-	-	-	O	-	-	O	O	-	
Jan	-	-	-	-	-	-	T	-	-	T	T	-	
Feb	-	-	-	-	-	-	O	-	-	O	O	-	
Mar	1.00	1.00	1.00	-	-	-	T	-	1.00	T	T	-	1.00
Apr	1.00	.83	1.00	1.00	.97	1.00	Y	1.00	1.00	Y	Y	1.00	.98
May	1.00	1.00	1.00	1.00	1.00	1.00	P	1.00	1.00	P	P	1.00	1.00
June	1.00	1.00	1.00	1.00	1.00	-	E	1.00	1.00	E	E	1.00	1.00
July	1.00	1.00	1.00	1.00	1.00	-	M	1.00	1.00	M	M	1.00	1.00
Aug	1.00	1.00	1.00	1.00	1.00	-	O	1.00	.94	O	O	1.00	.996
Sept	1.00	1.00	1.00	1.00	1.00	-	D	1.00	1.00	D	D	1.00	1.00
Oct	1.00	1.00	1.00	1.00	1.00	-	E	.97	1.00	E	E	1.00	.996
Nov	1.00	1.00	1.00	1.00	1.00	-	L	1.00	1.00	L	L	1.00	1.00

$$\text{Operation Ratio} - \frac{\text{1811 GP Units' Days of Actual Operation}}{\text{1820 GP Units' Days of Possible Operation}} = .995$$

CHARACTERISTICS OF PRESSURE SEWER SYSTEM PROJECT HOMES

TYPE OF HOUSE - 2 STORY TOWN HOUSE
AGE - 1 YEAR
LOT SIZE - 20' X 100'
APPROX. MARKET VALUE - $17,000 - $21,000
SOURCE OF WATER - CITY OF ALBANY
WASTEWATER DISPOSAL - CITY SEWER SYSTEM

NUMBER OF \ UNIT	1	2	3	4	5	6	7	8	9	10	11	12
PEOPLE	6	7	9	8	5	5	6	6	8	3	3	9
CHILDREN	4	5	7	6	4	4	4	4	6	2	2	6
BEDROOMS	4	4	5	5	4	4	4	5	5	3	3	5
BATHS	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	$1\frac{1}{2}$	1	1	$1\frac{1}{2}$

FIGURE 42

TABLE 12

SUMMARY OF GP UNITS MONTHLY AVERAGE
OPERATIONS PER DAY

DATE	GP UNIT	1	2	3	4	5	6	7	8	9	10	11	12
Oct 70	Ave.	35	10	16	12	11	-	13	10	18	11	8	-
	High	57	14	23	23	23	-	25	21	39	17	23	-
	Low	19	3	12	6	6	-	7	1	7	6	4	
Nov 70	Ave.	27	10	18	12	13	-	13	12	20	10	8	-
	High	56	17	25	21	23	-	26	21	38	23	15	-
	Low	2	5	13	8	6	-	5	8	10	4	4	-
Dec 70	Ave.	19	10	21	8	12	8	10	11	18	10	6	23
	High	40	14	36	15	18	11	18	18	26	17	14	33
	Low	5	6	2	4	6	3	4	7	1	5	1	1
Jan 71	Ave.	32	10	32	15	12	7	12	11	17	10	6	25
	High	48	13	52	22	23	12	29	18	28	17	13	33
	Low	21	5	18	11	6	3	6	7	3	6	2	15
Feb 71	Ave.	25	10	29	14	11	9	10	11	17	22	4	23
	High	38	32	40	25	21	15	24	29	34	29	11	29
	Low	8	6	18	8	5	4	5	3	1	13	2	19
Mar 71	Ave.	17	11	31	19	10	9	12	23	16	19	4	31
	High	35	17	44	28	30	15	26	30	28	27	8	40
	Low	8	2	12	12	4	5	6	14	8	11	2	21
Apr 71	Ave.	13	12	16	13	12	12	13	14	14	18	9	16
	High	24	22	23	20	28	28	25	23	24	36	17	20
	Low	6	2	13	6	5	1	8	6	8	5	2	8
May 71	Ave.	22	17	17	14	7	15	16	14	17	21	12	20
	High	37	41	31	34	23	26	42	32	26	36	22	30
	Low	11	7	12	8	1	5	6	9	8	9	6	13
June 71	Ave.	38	15	16	10	13	-	15	19	19	24	10	20
	High	53	22	27	21	42	-	29	39	46	41	20	29
	Low	23	6	10	7	3	-	9	9	11	12	4	9
July 71	Ave.	32	16	17	9	10	-	18	27	17	22	13	21
	High	45	26	26	19	27	-	33	44	25	40	36	40
	Low	9	6	10	1	3	-	9	13	6	8	6	11
Aug 71	Ave.	29	14	23	19	11	-	16	27	22	25	9	20
	High	55	28	42	35	31	-	34	36	33	46	16	33
	Low	10	4	12	9	1	-	7	18	10	12	5	12
Sept 71	Ave.	20	13	30	28	9	-	19	26	30	21	21	24
	High	33	23	49	40	10	-	44	49	46	45	18	46
	Low	6	1	15	19	7	-	9	18	21	7	13	16
Oct 71	Ave.	31	17	27	25	14	-	26	17	27	16	-	19
	High	53	31	39	38	35	-	49	29	42	29	-	25
	Low	13	1	18	10	6	-	10	7	18	10	-	13
Nov 71	Ave.	30	14	24	19	18	-	26	11	24	17	-	23
	High	36	24	30	32	31	-	54	21	35	26	-	32
	Low	20	9	18	11	6	-	10	13	16	10	-	19

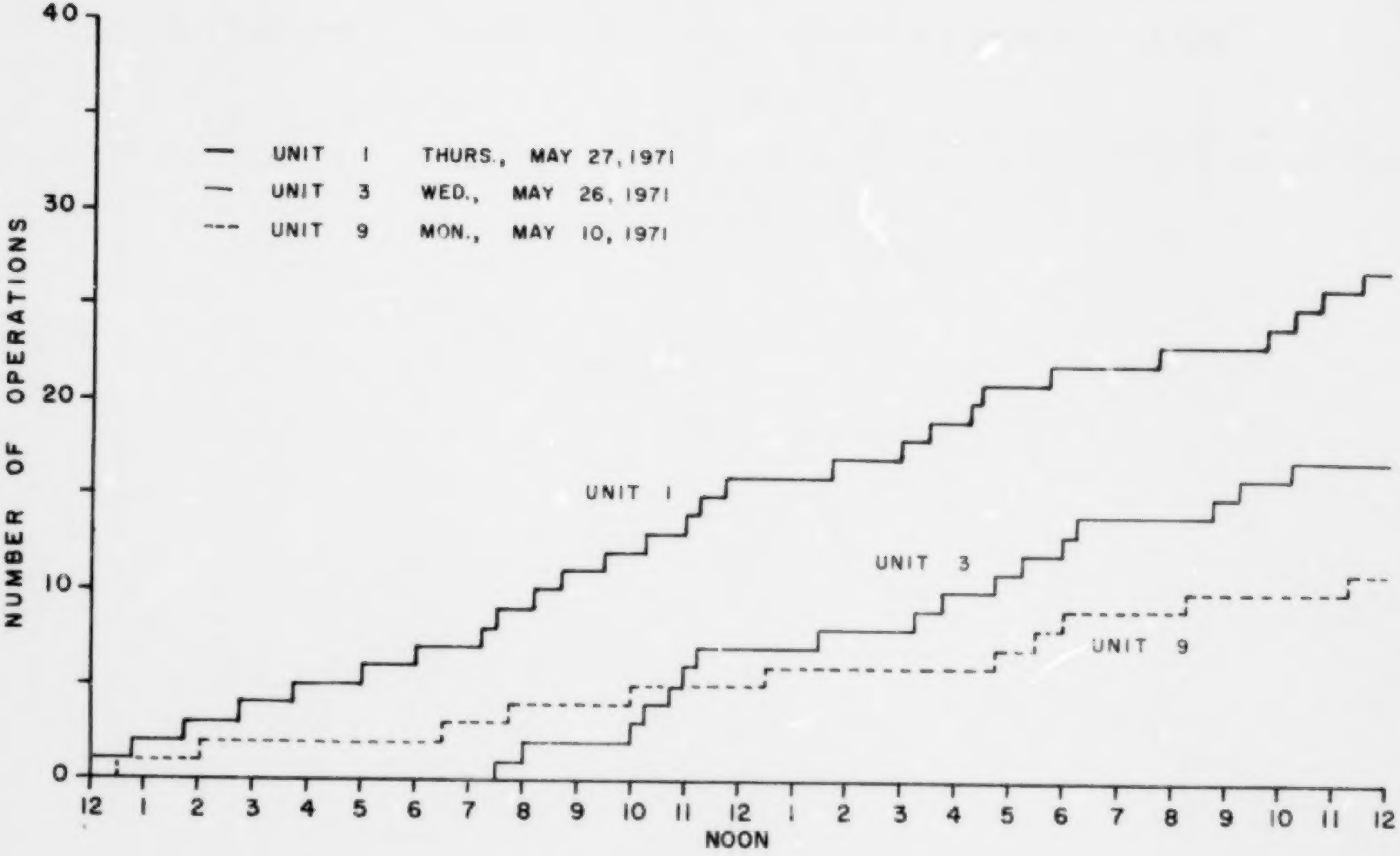


FIGURE 43 NUMBER OF OPERATIONS FOR WEEK DAY vs TIME OF DAY

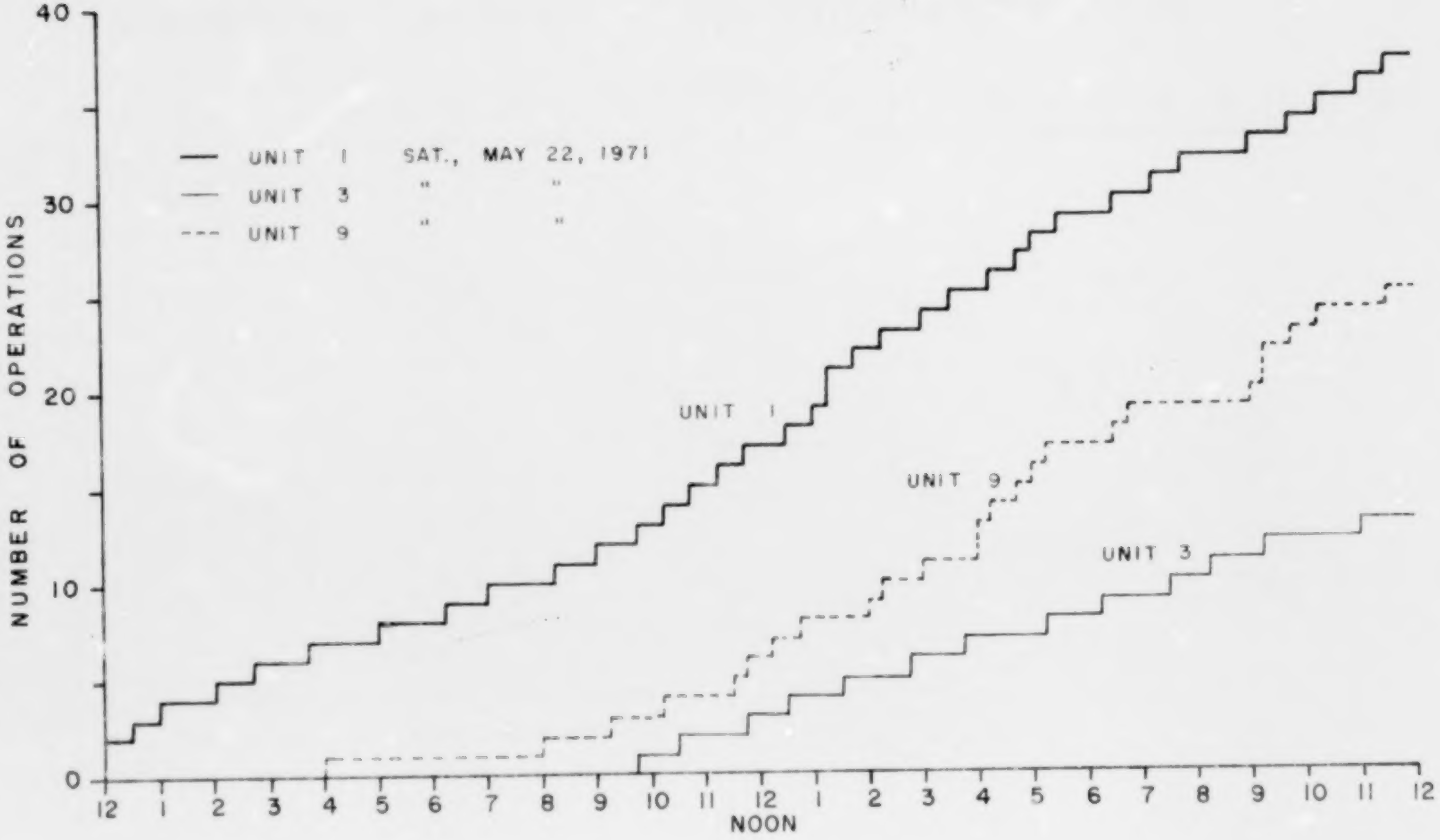


FIGURE 44 NUMBER OF OPERATIONS FOR WEEKEND vs TIME OF DAY

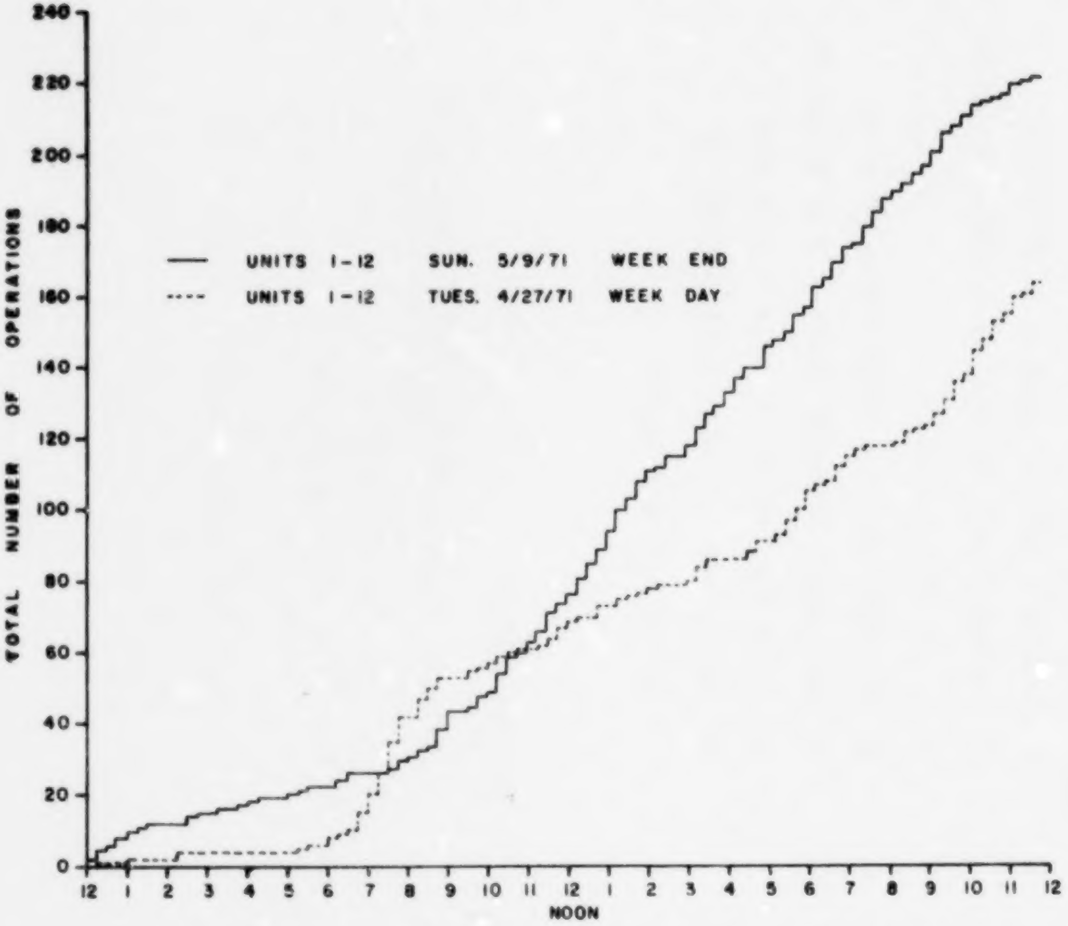


FIGURE 45 TOTAL NUMBER OF OPERATIONS vs TIME OF DAY

TABLE 13

THEORETICAL ANNUAL COST OF ELECTRIC ENERGY CONSUMPTION

DATA

1) ASSUMED FAMILY SIZE = 5 PERSONS
2) ASSUMED PER CAPITA WASTEWATER FLOW = 60 GAL/CAP/DAY
3) ASSUMED SYSTEM PRESSURE = 20 PSIG
4) NATIONAL AVERAGE COST = $ 0.015/KW-HR
5) PUMP OUT RATE AVERAGE = 12.8 GPM
6) PROTOTYPE POWER CONSUMPTION AT 20 PSIG = 990 WATTS

CALCULATIONS

$$\text{ANNUAL COST} = \frac{60 \times 5 \times 365 \times 990 \times 0.015}{12.8 \times 60 \times 1000}$$

$$= \$\ 2.12/\text{YR}$$

$$\text{EQUIVALENT MONTHLY COST} = \$\ 2.12/12$$

$$= \$\ 0.18/\text{MONTH}$$

TABLE 14 MONTHLY OPERATING COST PER UNIT* (Values are in Dollars)

	1	2	3	4	5	6	7	8	9	10	11	12
Oct. 70	.36	.13	.11	.12	.15	-	.14	.15	.12	.08	.15	-
Nov.	.25	.12	.11	.11	.16	-	.13	.18	.12	.07	.15	-
Dec.	.19	.12	.13	.08	.16	.15	.11	.18	.10	.07	.13	.17
Jan. 71	.32	.12	.20	.14	.16	.13	.13	.18	.10	.06	.12	.19
Feb.	.21	.11	.18	.10	.12	.12	.08	.13	.09	.14	.07	.14
March	.17	.11	.23	.19	.13	.18	.10	.37	.12	.14	.08	.22
April	.13	.12	.21	.13	.14	.15	.12	.15	.16	.12	.06	.18
May	.23	.20	.22	.14	.08	.08	.15	.14	.20	.15	.08	.23
June	.38	.18	.20	.10	.16	-	.14	.18	.22	.16	.06	.23
July	.33	.19	.22	.10	.11	-	.17	.26	.20	.15	.08	.25
Aug.	.29	.17	.30	.20	.13	-	.15	.27	.23	.17	.04	.23
Sept.	.19	.15	.35	.26	.09	-	.16	.24	.32	.11	.05	.25
Oct.	.31	.21	.35	.25	.17	-	.25	.17	.32	.11	-	.23
Nov.	.07	.04	.07	.04	.05	-	.06	.02	.06	.03	-	.06
Total Yearly Cost (11/1/70-10/31/71)	3.00	1.80	2.70	1.80	1.61	-	1.69	2.45	2.18	1.45	1.18	2.32

*An incremental power consumption rate of 2.3¢ per KWH was used to arrive at these values.

for due to the fact that Unit No. 1's total yearly operations are double that of Unit No. 2 and their monthly operational usage is in the same range.

Based on the incremental power consumption rate of $0.023 per KWH, a table was prepared indicating the monthly variation for each of the twelve units and the yearly cost for the 12 months period beginning November 1, 1970 and terminating October 31, 1971 (Table No. 14). These values were arrived at by multiplying the total monthly operations by the average time of an operating cycle and the power consumption (watts) for each of the units under a given dynamic head. Table 15 represents a typical calculation performed by computing the monthly operating cost for each of the twelve town houses.

Table 15 - AVERAGE MONTHLY COST COMPUTATION

Data:

(1)	Number of Operations - October, 1970	1,097
(2)	Average Length of an Operational Cycle	58 sec.
(3)	Power Consumption for a given Dynamic Head	900 watts @ 5 psi
(4)	Cost of Electric Energy	$0.023 per KWH

Calculation:

$$\text{Monthly Cost} = \frac{1{,}097 \times 58 \times 900 \times .023}{60 \times 60 \times 1{,}000} = \$0.37$$

Maintenance Requirements

A telephone call from the remote controlled tape recorder within the field office trailer indicated the occurrence of a malfunction at the demonstration project. Upon arrival at the site, the malfunction was located and appropriate steps were taken to have it repaired as soon as possible.

Most of the malfunctions were such that a single person was able to make the necessary repairs. Occasionally, a second person was necessary for the purpose of lifting the GP core out of the tank. The core itself weighs about 140 lbs.

A stock of spare parts (at least six of each) was kept at the field office trailer including a complete core unit. Basic mechanic's tools, flashlight and a volt-ohm-meter were all the equipment needed in order to make the necessary repairs.

For this particular demonstration project, a number of engineers and technicians were qualified to perform repair work on the GP units. However, no preventive maintenance was performed for the duration of the project since the manufacturer of the GP units did not recommend any such maintenance.

In order to summarize the monthly maintenance work, a Service Ratio Value was introduced at the outset of the actual field demonstration.

This parameter was computed by taking the number of Unit Days requiring service divided by the number of Unit Days of actual Operation Accomplished.

Table 16 gives the results of the Service Ratios for each of the twelve GP units and for the entire pressure sewer system. Again, as was indicated by the Operation Ratio, the Service Ratio also confirms an important performance record for the new GP units. A special Service Ratio (Table 17) has been calculated for the nine new GP units from the period of their installation until the termination of the project.

Overflow Occurrences

The staff of American Society of Civil Engineers Project on Separation of Combined Sewers gathered some data on wastewater flows from individual homes(16,17). This information was used to design a tank having a storage capacity of at least 44 gallons(9).

It was necessary to confirm the adequacy of the tank storage capacity. Therefore, the automatic monitoring equipment was capable of recording the length of time of any overflow occurrences. As mentioned in previous chapters, the two types of tanks used in this project had a gross storage capacity of 60 and 80 gallons and peak flow storage capacity of 30 and 43 gallons respectively.

A natural overflow would have occurred only when the quantity of wastewater entering the tank was so great that the pump could not adequately handle this peak flow. The storage capacity would then have been utilized with an ensuing overflow occurrence if the peak flow continued.

After reviewing the computer printouts, no data was found to substantiate any inadequacy in the storage capacity of the tanks, when used in combination with pumps of the capacity previously indicated (i.e. 11 to 16 gpm).

Discussion

The mechanical performance of the prototype GP units was somewhat disappointing. The number of malfunctions for the first six months appeared excessive. More than one malfunction occurrence per month for the entire 12 units' pressure system would make the GP unit mechanically unfeasible.

Basically, the cause for the majority of the malfunctions during the prototype phase was the extensive grease build-up within the 1" bellshape pressure sensing tube. Figure 31 represents the cross-sectional area of the 1" tube with the surprisingly large build-up. This accumulation occurred only after 5 months of operation, and completely clogged the opening. The modified bell-shaped pressure sensing tube with a 3" opening,

TABLE 16 - SUMMARY OF SERVICE RATIOS (OVERALL)

$$\text{S.R.} = \frac{\text{Unit Days' Requiring Service}}{\text{Unit Days' of Actual Operation}}$$

House # Month	1	2	3	4	5	6	7	8	9	10	11	12	Project Ratio
Oct	0	0	0	0	0	-	0	0	0	0	0	-	0
Nov	.074	0	.034	0	0	-	0	0	.077	0	0	-	.017
Dec	0	0	.077	0	0	0	0	0	.040	0	0	0	.008
Jan	0	0	.067	0	0	0	0	0	.083	0	0	0	.011
Feb	.042	0	0	.083	.038	.087	.043	.182	.040	.037	0	0	.042
March	0	.040	.033	0	0	0	.042	0	0	0	0	.034	.011
April	0	.080	0	0	.035	0	0	.036	0	0	0	0	.014
May	0	0	0	0	0	0	0	0	0	0	0	0	0
June	0	0	0	0	0	-	0	0	0	0	0	0	0
July	0	0	0	0	0	-	0	0	0	0	0	0	0
Aug	0	0	0	0	0	-	0	0	.067	0	.157	0	.015
Sept	0	0	0	0	0	-	0	0	0	.038	.455	0	.019
Oct	0	0	0	0	0	-	0	.033	0	0	-	0	.003
Nov	0	0	0	0	0	-	0	0	0	0	-	0	0

Total Service Ratio = .011

TABLE 17 SUMMARY OF SERVICE RATIOS FOR THE MODIFIED UNITS

House # Month	1	2	3	4	5	6	7	8	9	10	11	12	Service Ratio
Oct.	-	-	-	-	-	-		-	-			-	
Nov.	-	-	-	-	-	-		-	-			-	
Dec.	-	-	-	-	-	-		-	-			-	
Jan.	-	-	-	-	-	-		-	-			-	
Feb.	-	-	-	-	-	-		-	-			-	
March	0	0	0	-	-	-		-	0			-	0
April	0	.080	0	0	.034	0		0	0			0	.011
May	0	0	0	0	0	0		0	0			0	0
June	0	0	0	0	0	-		0	0			0	0
July	0	0	0	0	0	-		0	0			0	0
Aug.	0	0	0	0	0	-		0	.069			0	.008
Sept.	0	0	0	0	0	-		0	0			0	0
Oct.	0	0	0	0	0	-		.033	0			0	.004
Nov.	0	0	0	0	0	-		0	0			0	0

$$\text{Service Ratio (S.R.)} = \frac{\text{GP Units' Days Requiring Service}}{\text{GP Units' Days of Actual Operation}} = \frac{6}{1823} = .003$$

shown in Figure 32, eliminated any further clogging.

A secondary cause for many of the malfunctions was the GP units' pumps losing their prime. In part, this problem can be attributed directly to the inability of the pressure sensing tube to function properly. The failure on its part to shut down the motor caused a large quantity of air to be introduced into the system. Upon the Unit's next operation, the pump accordingly failed to function preventing the proper discharge of the macerated wastewater from the tank.

Having modified the new GP units by relocating the pump within the bottom portion of the tank, all problems related to its malfunctioning were eliminated. Malfunctions No. 28 and 29 can be directly related to the work performed during the installation of the new units. Air was introduced into the system during this period and failure to bleed the air out of the discharge pipes caused these two malfunctions.

Only five out of the forty-four recorded malfunctions were attributed to the new units. This enormous reduction can be directly related to the two basic design modifications: (1) Increasing the bell-shaped pressure sensing tube opening from one inch to three inches, and (2) locating the pump within the tank so that it is always positively primed.

As for the actual operation of the GP units, the great variation in the total number of daily on-off operations is indicative of the thorough testing that these GP units were subjected to. (Table 12)

Figure 46 was constructed to show the variations for three GP units, which demonstrated low, average and high operational usage for this project. Low values of zero, one or two operations were not unusual; similarly, high values of 56 and 57 operations were common for the duration of the project.

There was no noticeable seasonal variation as far as the total number of operations for the demonstration project was concerned. A slight increase in the total number of operations during the second half of the project can be accounted for by the fact that all washing machine discharges were re-routed to the GP tank. Because of this, a much closer relationship was evident between the water and wastewater flows (see Section VII). Also, the newer units had slightly shorter operating cycles because of new times and pressure sensing relays.

No direct relationship can be established between any of the units regarding their total number of operations vs occupants. For instance, Unit No. 2, which had a greater number of occupants than Unit No. 1, registered less than half of the total operations tabulated for Unit No. 1. Factors such as daily pattern of living, number of working adults, number of pre-school and school age children, etc., greatly affected the number of operations from house to house.

The daily operating time for each of the units also varies greatly as a result of the same facto as stated above. However, the data does rein-

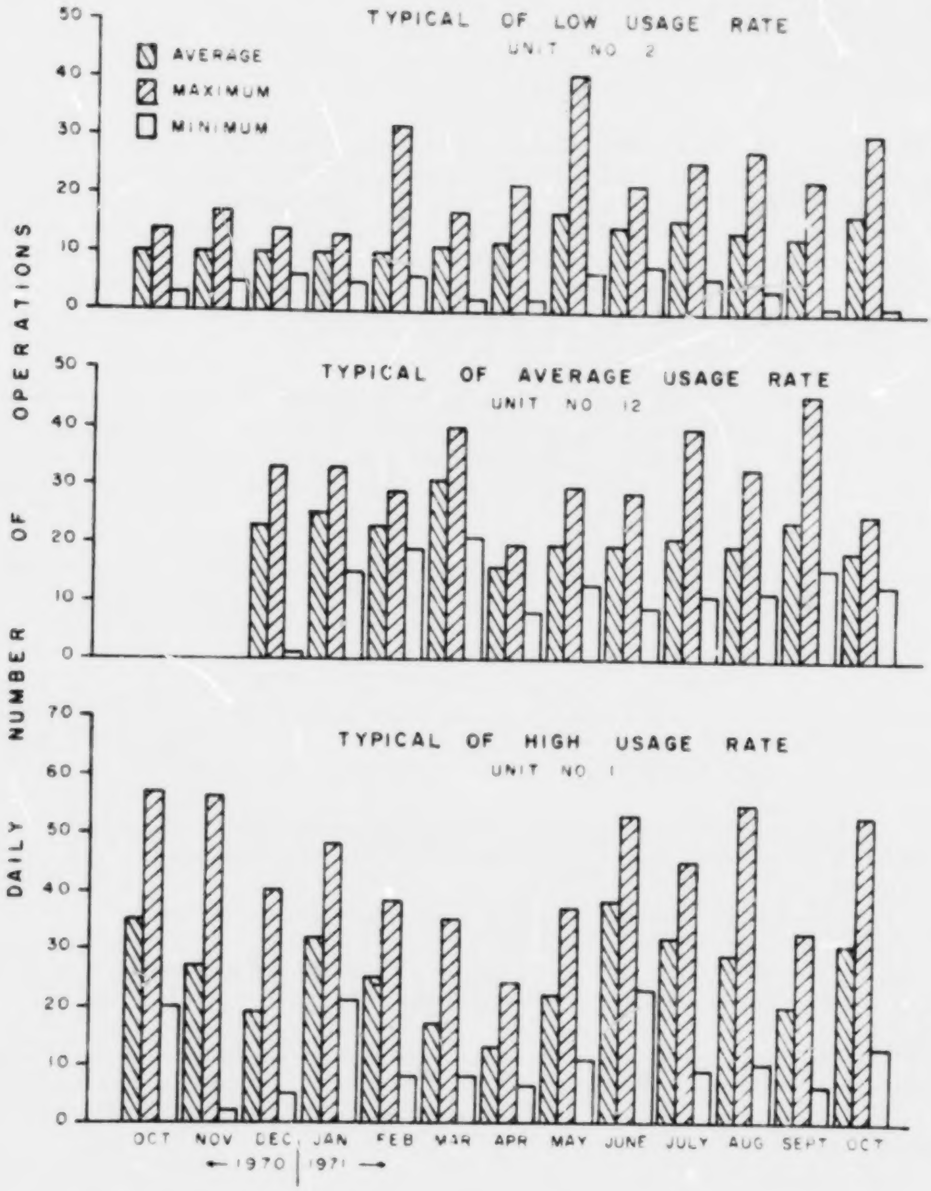


FIGURE 46 TYPICAL USAGE RATE OF GP UNITS

force previously quoted values of ten (10) to thirty (30) minutes for the total operating time per day.

Perhaps the best indications on the performance of modified GP units are given in Tables 11 and 17. An Operation Ratio of 0.995 and a Service Ratio of 0.003 were achieved for the last seven and a half months of operation in comparison to an Operation Ratio of 0.958 and a Service Ratio of 0.015 for the first six months.

Every attempt was made to have the values of the Operation and Service Ratios kept to an absolute minimum. However, occasionally, as can be noted in the descriptions of the different malfunctions, a few days passed before service was restored to normal.

The research staff was very careful to avoid creating personal friction between members of the staff and the residents of the town houses. The performance of service on certain occasions was delayed in order not to inconvenience these residents. In this particular demonstration project, the overflow system to the conventional sewer system afforded the luxury of permitting, when necessary, a delay in performing repair work. This is one of the principal reasons that the Operation Ratio at times is much larger than desired.

A new parameter - "down time" - can be introduced in order to further exemplify the performance record of the new GP units. This parameter, expressed as a percentage, equivalent to the total number of hours any given unit was out of service over the total number of hours of possible operation.

For the first six months, the prototype GP units produced a "down time" of 2.69%, which appears to be unacceptable for this type of system, while during the second half of the project, the modified GP units alone showed a more acceptable "down time" of 0.27%. (Table 18)

Even though both of these values could have been reduced by a wide margin, the first six months still would have produced such a high value that the prototype GP units would have been mechanically unfeasible.

Also, as was expected from this particular development, there were four distinct peak periods of usage during a normal work week:

(a) Early morning - start of a work and school day
(b) Noon - lunch period
(c) Mid-afternoon - children returning from school
(d) Early evening - dinner hour

On the other hand, weekends did not produce any distinct peak usage period, even though the total number of GP unit operations were increased by as much as seventy operations. A much more evenly distributed GP unit usage occurred during this forty-eight hour period.

TABLE 18 "DOWN-TIME" PERFORMANCE RECORD

(Expressed as Percentage)

Unit #	Prototype Model	Modified Model
1	2.6	0
2	2.9	1.9
3	2.9	0
4	1.0	0
5	0.4	0.20
6	1.3	N.A.*
7	2.6	-
8	2.3	-
9	6.7	0.70
10	2.0	0.10
11	14.7	-
12	0.8	0

*N.A. No data available due to vacancy of Unit No. 6

The operating cost (power consumption) of the individual GP unit is absolutely minimal. For this project, the average yearly cost was calculated to be thirty-two cents per capita with great variations existing between the individual households. Therefore, the operating cost, exclusive of maintenance, should not be a factor when considering the economics of a pressure sewer system.

Finally, the tanks used in the demonstration project were able to provide the necessary storage during peak wastewater flows. No overflows occurred which were not directly attributed to mechanical failures on the part of the GP units.

Conclusions

A. The mechanicalperformance of the prototype GP units was totally unacceptable because the high number of malfunctions (39 in all) produced:

   a. Low operation ratio - .958
   b. High service ratio - .015
   c. High "down time" - 2.69%

   On the other hand, the modified GP units were much more mechanically feasible because the low number of malfunctions (5 in all) produced:

   1. High operation ratio - .995
   2. Low service ratio - .003
   3. Low "down time" - 0.27%

B. A majority of the prototype malfunctions were attributed to the heavy grease accumulation on the inside of the one inch bell-shaped pressure sensing tube, and to the loss of prime by the GP units' pump.

C. Corrective modifications in the design of the GP units prevented any further malfunctions by the pressure sensing tube and pump. The opening in the pressure sensing tube was increased from one inch to three inches and the pump was relocated near the bottom of the tank.

D. There were over 79,740 operations of the GP units for the demonstration period. The average contribution per capita per day for this demonstration project amounted to 2.6 operations. The average operating cycle for the new modified units varied from 57 to 74 seconds.

E. No distinct seasonal variations in the usage of the GP units were noted. Four peak periods were recorded during a typical weekday: early morning, noon, mid-afternoon and early evening with great variations in the daily operation from unit to unit.

F. Operating cost for the demonstration project amounted to 34¢ per capita per year.

G. The pump size and tank capacity were more than adequate to handle any peak wastewater flows. No design modifications are necessary in this area.

SECTION VII

PRESSURE SEWER SYSTEM'S HYDRAULICS

Introduction

Before the demonstration project was initiated, it was thought that the success of a pressure sewer system was for the most part dependent on the product, i.e. the reliability of the GP units. However, at the conclusion of the project, the reliability of the GP units was well documented and proven but what emerged as the critical parameter of a pressure sewer system was its hydraulic characteristics.

This section will focus its attention on the hydraulics of the system emphasizing the data necessary to evaluate a major objective of the demonstration, that is, to document the effectiveness of small diameter, non-metallic pressure sewers in carrying routinely the wastewater from a number of residential buildings over an extended period of time including seasonal changes and some prolonged periods of disuse (long weekends, vacation and the like).

Description of Pressure Sewer Piping System

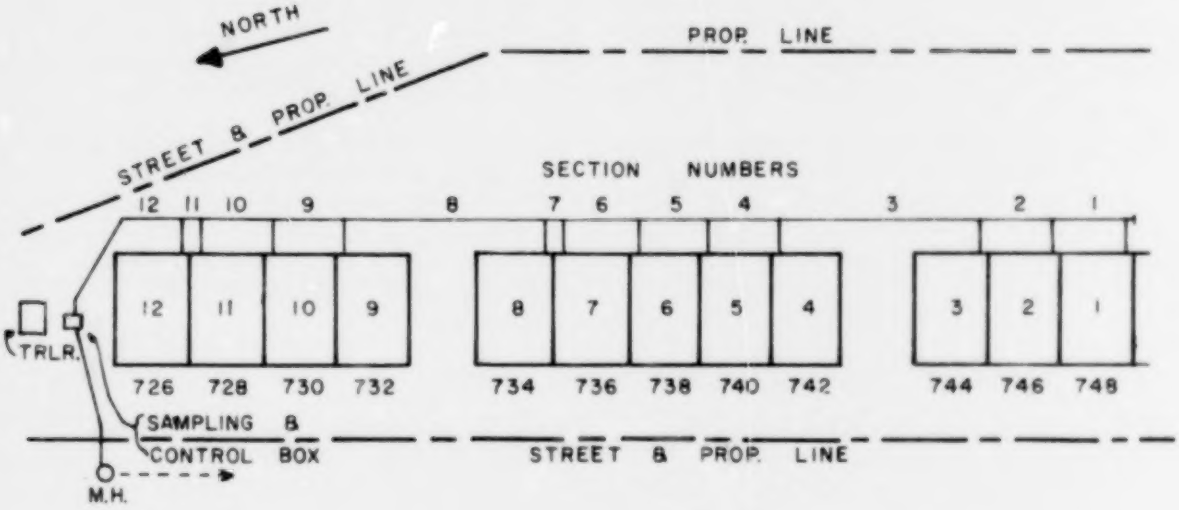
The pressure sewer system's pipe sizing was based on the ASCE minimum scouring velocity criteria(22) for pressure sewers and on certain engineering assumptions regarding the estimated wastewater flows from the 12 GP units. A summary of the parameters utilized in the final design of the pressure sewer system is presented in Table 19. No data was available on the scouring velocity for pipe sizes less than 2"(22).

It must be understood that the flows in the different portions of the pressure main were based strictly on an engineering estimate. There was no data available on the frequency of GP operations for a multiple units system. It was possible to predict the peak usage hours of the GP units, but since the operating cycle per GP unit is very small, 57 secs. to 74 secs., it was almost impossible to predict the number of units working simultaneously during this peak period. It was, therefore, assumed that a maximum flow of 90 gpm would flush regularly that portion of the pressure main serving all 12 GP units.

It was also assumed that a minimum flow of 60 gpm would occur routinely over a 24 hour period. The 60 gpm value was equivalent to 4 GP units operating simultaneously. Based on this minimum flow and a proportionate reduction of the flow down the pressure main, the calculated velocity was greater than the recommended minimum scouring velocity(23) of $V_s = \frac{\sqrt{D}}{2}$ in all portions of the pressure main.

TABLE 19

SUMMARY OF ASSUMED HYDRAULIC DESIGN PARAMETERS FOR PRESSURE SEWER


NORTH
PROP. LINE
STREET & PROP. LINE
SECTION NUMBERS
12 11 10 9 8 7 6 5 4 3 2 1
12 11 10 9 8 7 6 5 4 3 2 1
726 728 730 732 734 736 738 740 742 744 746 748
TRLR.
SAMPLING & CONTROL BOX
STREET & PROP. LINE
M.H.

SECTION NUMBER	PVC - DWV PIPE SIZE	APPROX. LENGTH OF SECTION (FT)	ASSUMED MAX. FLOW (GPM)	ASSUMED MIN. FLOW IN 24 HR. (GPM)	CALC. VELOCITY MIN. FLOW (FPS)	MIN. VEL. SCOURING CRITERIA PER ASCE (FPS)
1	1.25	20	15	15	3.76	N.A.
2	2.0	20	30	↓	1.63	0.846
3	↓	40	45	↓	1.63	↓
4	↓	20	↓	30	3.26	↓
5	↓	20	↓	↓	3.26	↓
6	3.0	20	60	↓	1.44	0.930
7	↓	20	↓	45	2.18	↓
8	↓	40	↓	↓	2.18	↓
9	↓	20	75	↓	2.18	↓
10	↓	20	↓	60	2.92	↓
11	↓	20	↓	↓	2.92	↓
12	↓	60	90	↓	2.92	↓

The piping system from the GP unit to pressure main to discharge point is shown in Figure 47. The 1¼" PVC pipe size was recommended as the discharge pipe from the individual GP units(2). The frictional head losses for the 1¼" pipe compared to 1" and 1½" pipe sizes are presented in Figure 30.

Installation

Plans and specifications were prepared and a contract let to a plumbing contractor for the installation of the pressure sewer system. The specifications called for PVC Type I Schedule 40 pipes, PVC-DWV fittings and PVC solvent cement. As stated in a previous chapter, a temporary variance in the City of Albany's Plumbing Code had to be obtained for the duration of the demonstration.

The plumbers lacked experience in the installation of PVC materials. As a result, a number of leaks were discovered when the system was pressure tested at 80 psig. The pressure test was performed before the pipes were backfilled. As a result, the repair work was accomplished rather quickly with little delay. Figures 48 and 49 show the project during the installation phase of the contract.

The pressure main was located 18 feet from the rear of the town houses (row houses) and it varied from 1¼" at Unit No. 1 to 3" in size at the discharge end of the main.

The purpose of using PVC-DWV fittings was that they afforded a smoother transition rather than the sharp angular transition of the schedule 40 or 80 fittings. Sanitary tees with the additional 45° elbows were used to make the final connection from house to the pressure main as shown in Figure 50. Whenever possible, a common excavation trench was used for the installation of two lateral pressure pipes (Figure 51). Also, all pipe size transitions were made at the point where a lateral entered the pressure main. This was accomplished by utilizing Sanitary Tees and reducing bushings (Figures 52 and 53).

As a final precaution in order to protect the PVC pipe from any physical damage during backfilling operations and thereafter, the specification was later changed to call for an additional 12" of sand top cover, because of large boulders and bricks, which were part of the fill material for that area.

Results

Wastewater Flows

There were no direct recordings made of the wastewater flows from the Pressure Sewer System. Therefore, the wastewater flows were based on four (4) related sources: 1) Total water flow within each of the twelve individual units; 2) Wastewater compositor recordings (see Section VIII); 3) Total operating time for the twelve GP units; and 4) Event recorder data on the number of operations.

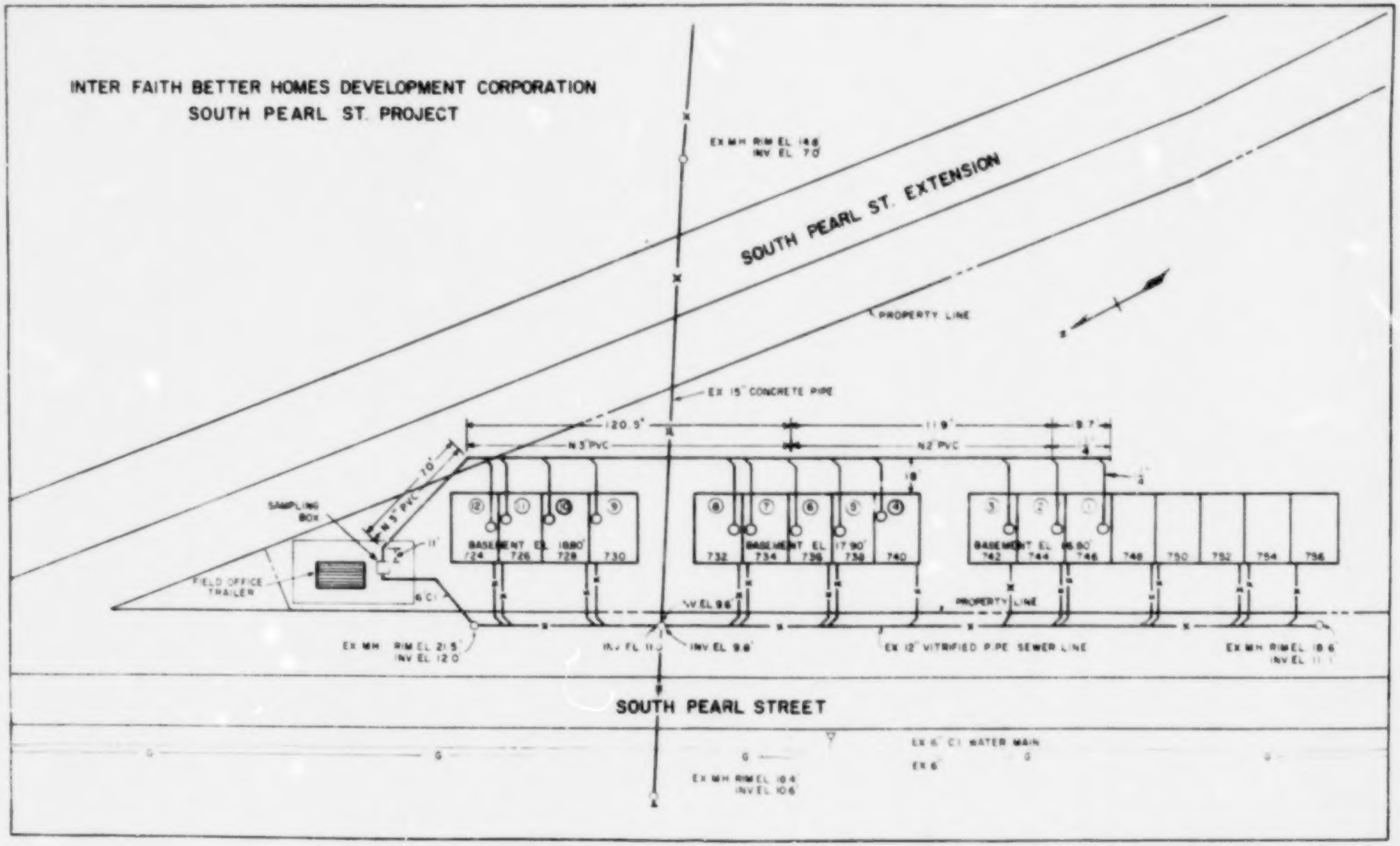

INTER FAITH BETTER HOMES DEVELOPMENT CORPORATION
SOUTH PEARL ST. PROJECT
EX MH RIM EL 14.6
INV EL 7.0
SOUTH PEARL ST. EXTENSION
PROPERTY LINE
EX 15" CONCRETE PIPE
120.5'
119'
9.7'
N 3" PVC
N 2" PVC
18'
10'
N 3" PVC
SAMPLING BOX
11'
FIELD OFFICE TRAILER
6" C.I.
12
11
10
9
8
7
6
5
4
3
2
1
BASEMENT EL 18.80'
BASEMENT EL 17.90'
BASEMENT EL 16.80'
724
726
728
730
732
734
736
738
740
742
744
746
748
750
752
754
756
INV EL 9.6'
PROPERTY LINE
EX MH RIM EL 21.5'
INV EL 12.0'
INV EL 11.0
INV EL 9.8'
EX 12" VITRIFIED PIPE SEWER LINE
EX MH RIM EL 18.6'
INV EL 11.1
SOUTH PEARL STREET
EX 6" C.I. WATER MAIN
EX 6"
G
EX MH RIM EL 18.4'
INV EL 10.6'

FIGURE 47

PIPING SYSTEM FROM GP UNITS TO PRESSURE MAIN TO DISCHARGE POINT

FIGURE 48

PHOTO OF PROJECT DURING INSTALLATION PHASE

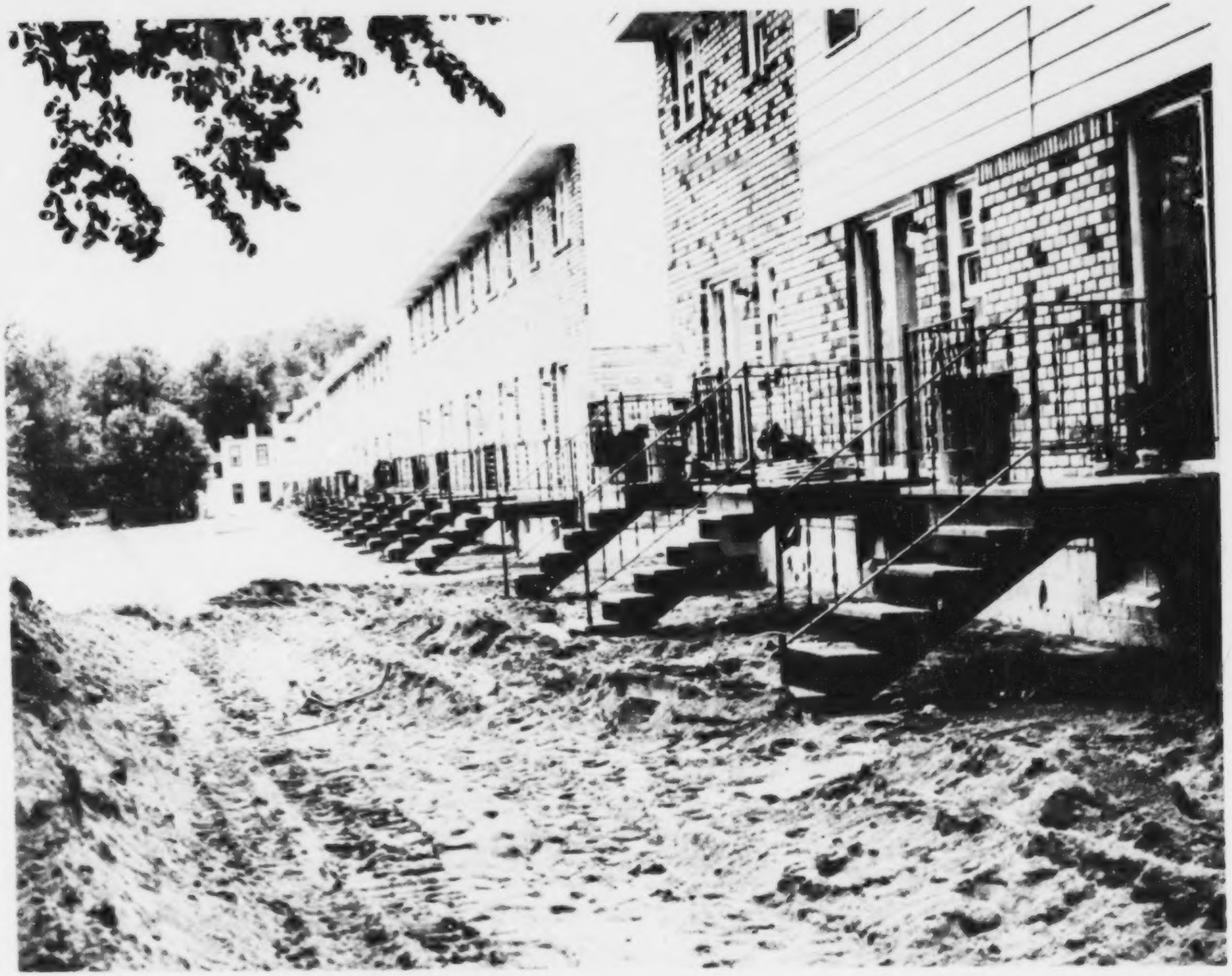


FIGURE 49
PHOTO OF PROJECT DURING INSTALLATION PHASE

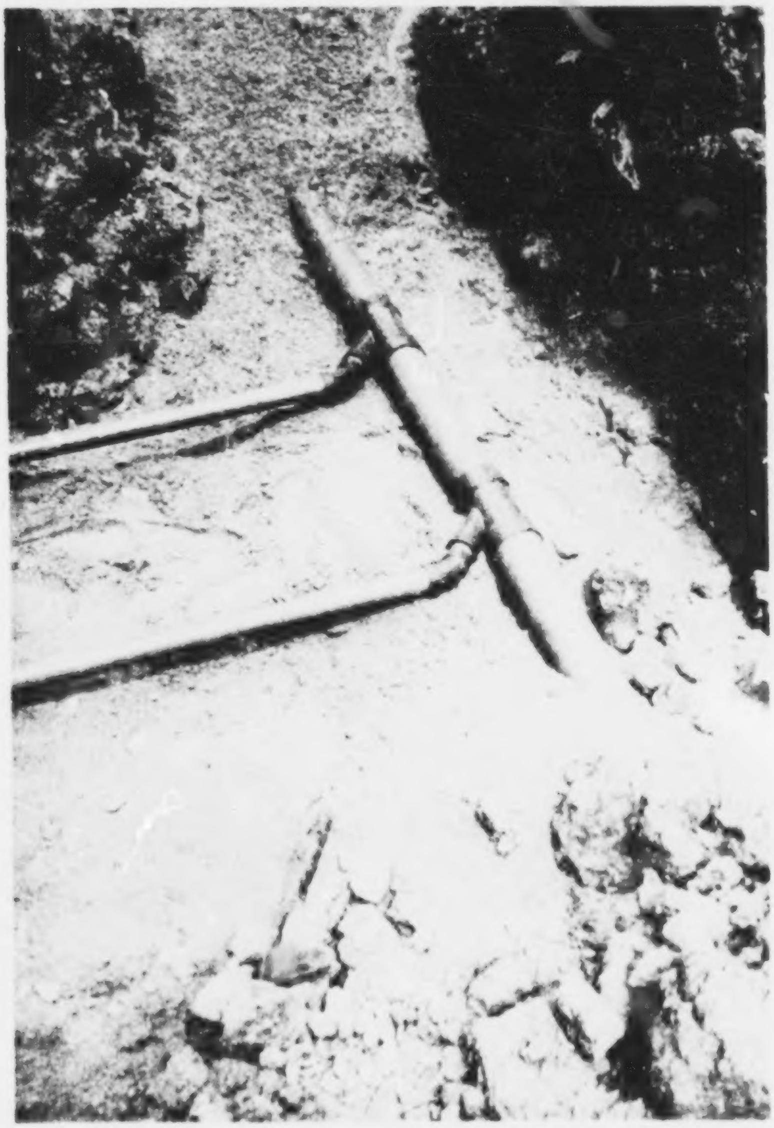


FIGURE 50

CONNECTION OF PRESSURE LATERALS (1¼")
TO PRESSURE MAIN (3")

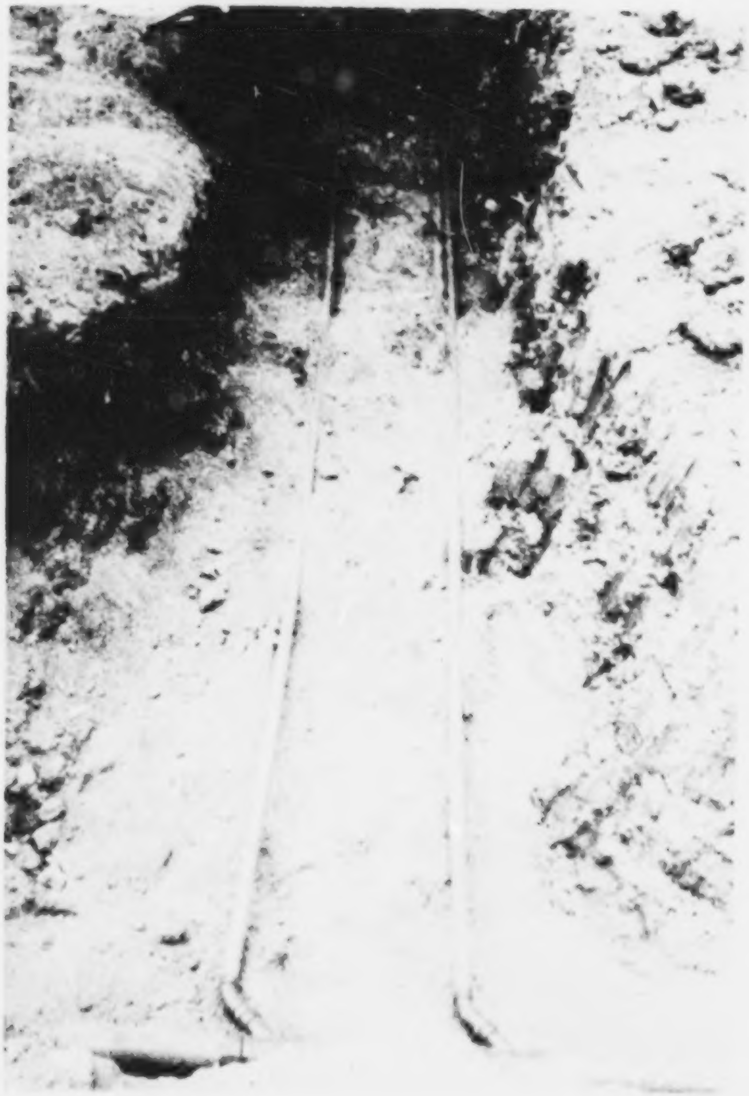


FIGURE 51

COMMON EXCAVATION DITCH
FOR PRESSURE LATERALS

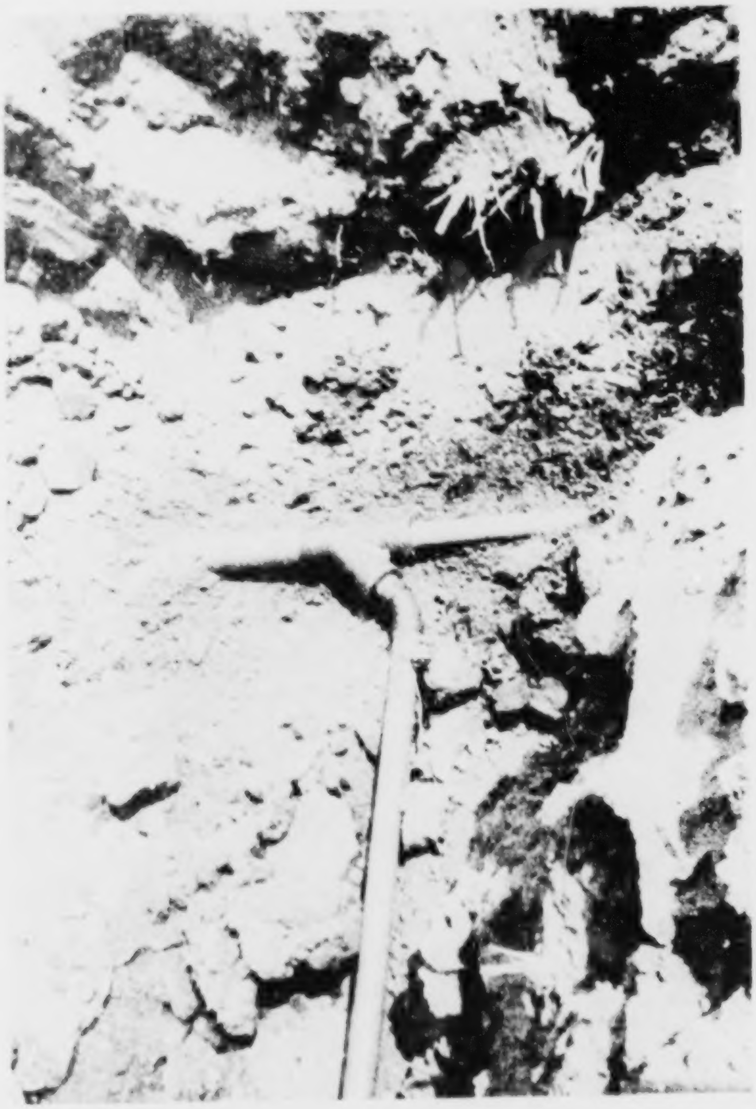


FIGURE 52

SUDDEN ENLARGEMENT (1¼" X 2")

AT LATERAL CONNECTION WITH PRESSURE MAIN

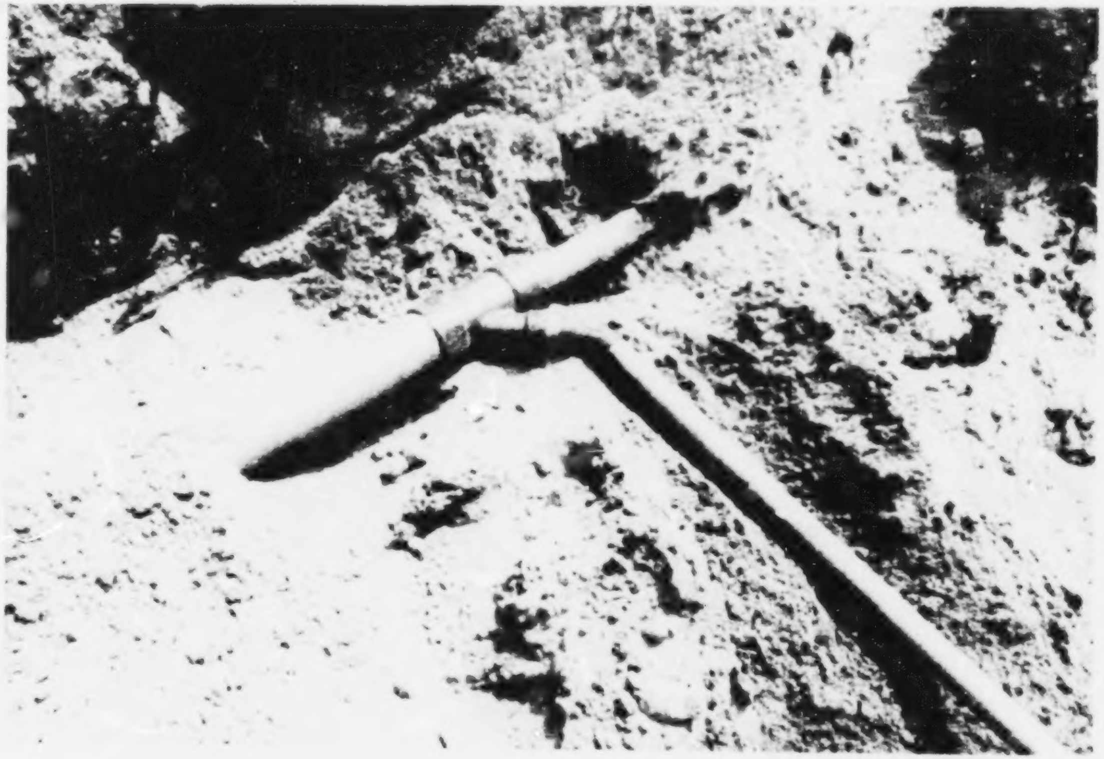


FIGURE 53

SUDDEN ENLARGEMENT (2" X 3")
AT LATERAL CONNECTION WITH PRESSURE MAIN

1) Water Flows

An extensive data collection system was designed to record the water flows within each of the twelve individual town houses since very little information had been available regarding the individual home's water usage in the past. This demonstration project presented an opportunity to thoroughly document household water flows and relate them to the wastewater flows from the individual GP units. A description of the water flow recording system which can be found in Section IV of this report, notes that outside uses such as lawn watering etc., were excluded.

A summary of weekly, monthly, fifteen minute, and one hour peak flows as well as the total flow is presented in Appendix E. In addition, daily, weekly and monthly flows per capita were calculated based on the original occupancy survey of the project town houses.

During the second phase of the project, the total wastewater flows ranged between 95 and 100 percent of the recorded water flow (Figure 54). Figure 55 represents the relationship between the fifteen minute water flow values over a 24 hour period and the wastewater flows based on the individual GP unit operations. The close correspondence between these two hydrographs demonstrates that the water flows measured are a highly reliable indicator of the corresponding wastewater discharges.

2) Wastewater Compositor

The operation and usage of the compositor is described in Section VI of this report. It is sufficient to say at this time that the wastewater compositor was especially fabricated by the Research Staff and was used to collect representative samples of the effluent from the pressure main for chemical analyses. The compositor was electrically connected to the event recorder so that accurate records were made of the total number of compositor operations. Figure 56 represents the direct relationship between the total number of compositor operations and the wastewater flows.

This relationship was extremely important for those days when there were no water flow records available, since it was possible to compute the total wastewater flow based on the number of compositor operations.

3) Total Operating Time

It was noticed on numerous occasions that the daily computer summary sheet indicated a higher pumping rate for an individual GP unit than possible. The pumping rate was computed by dividing the total water flow by the total operating time. This being the case, it was discovered that an excess water flow was caused by the usage of the basement sink for clothes washing and other related activities. As

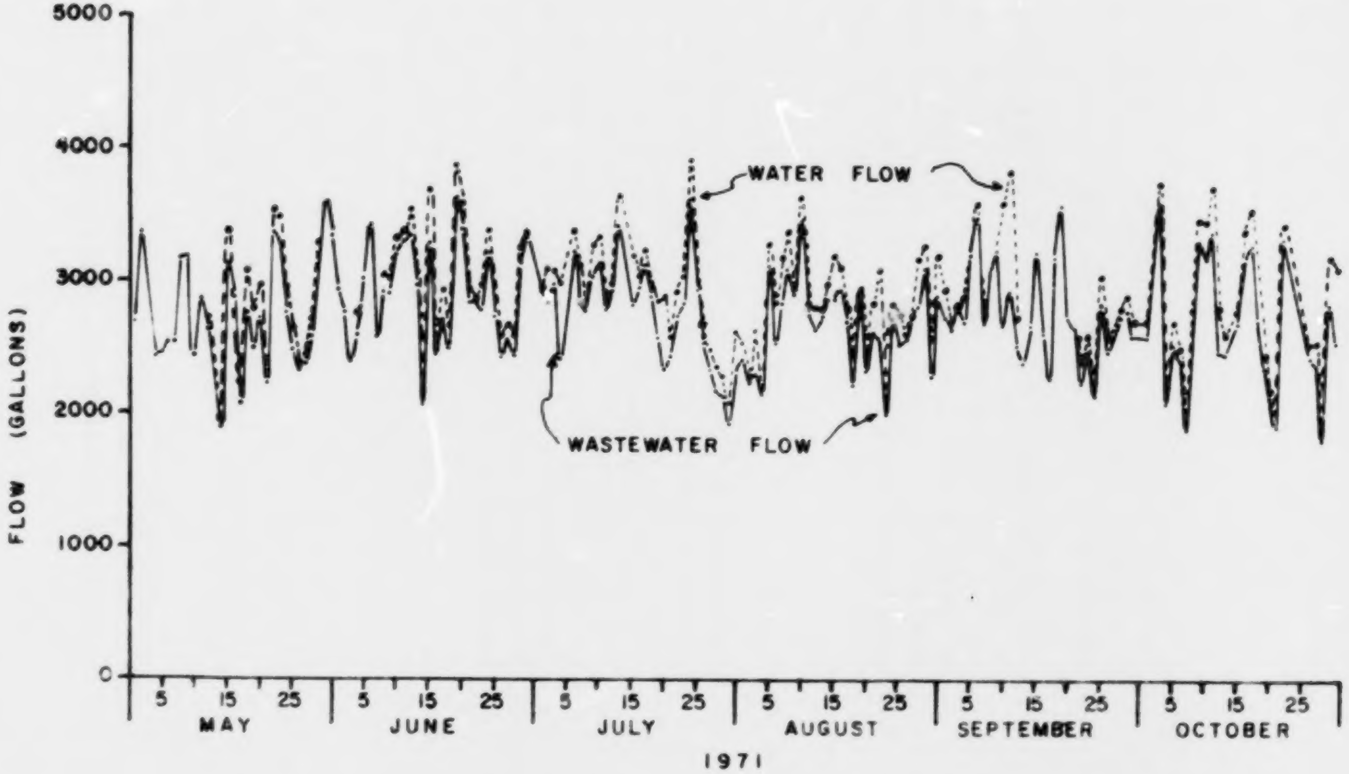


FIGURE 54 WASTEWATER AND WATER FLOWS

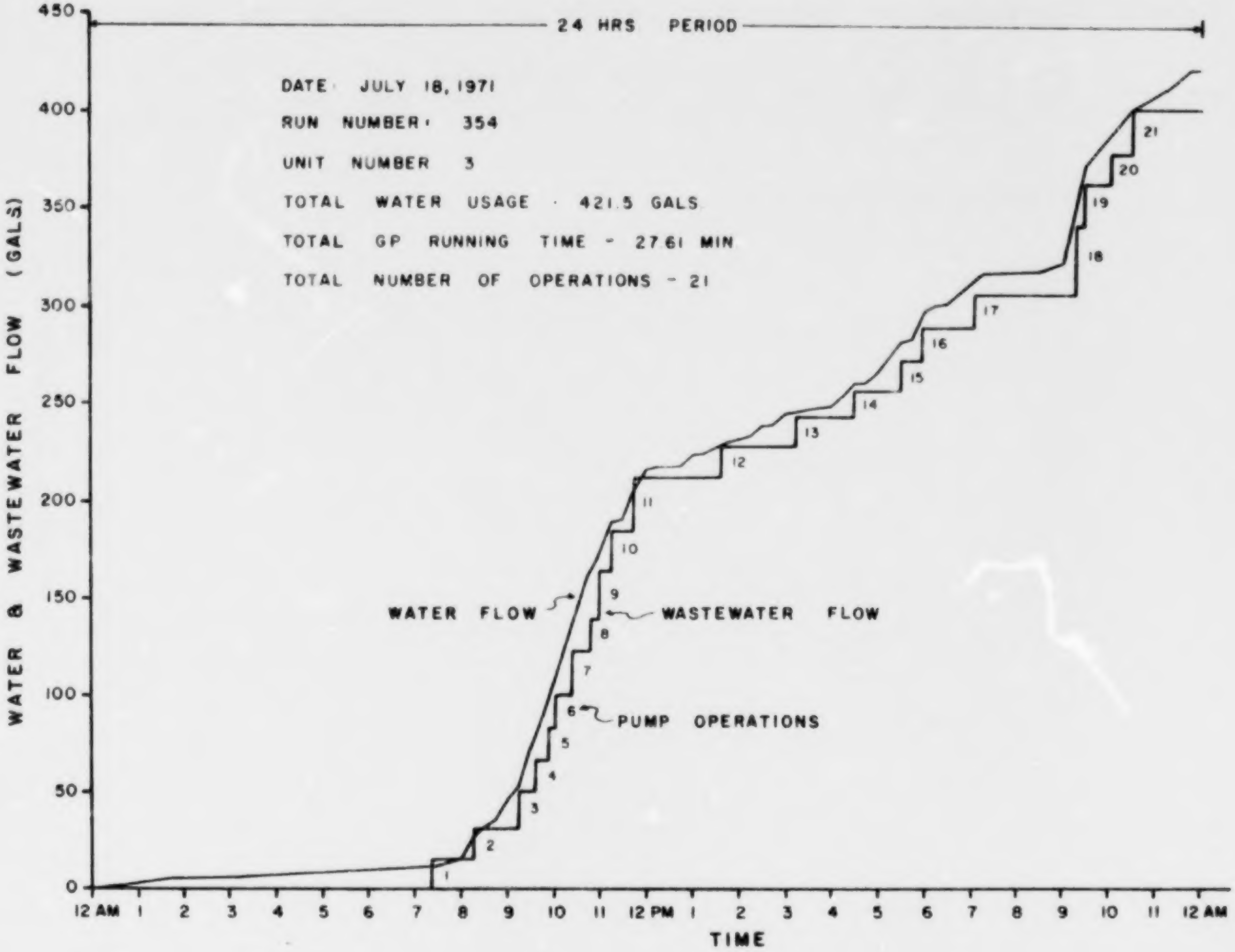


FIGURE 55
WATER FLOW vs TIME
AND
WASTEWATER FLOW vs TIME

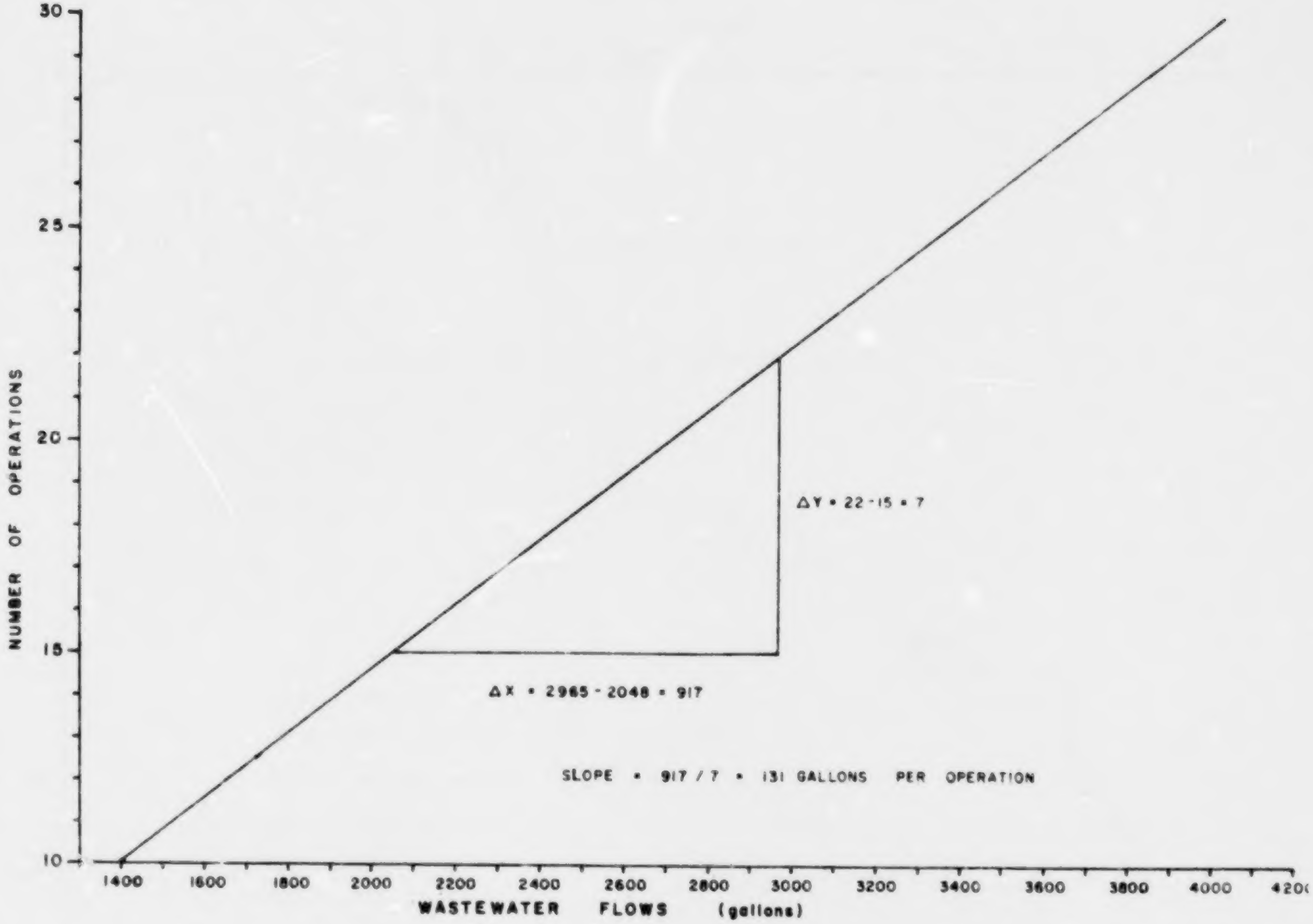


FIGURE 56 NUMBER OF COMPOSITOR OPERATIONS vs WASTEWATER FLOWS.

reported before, the basement sink was not originally connected to the pressure system so that any water used there would bypass the GP unit and flow directly into the city's sanitary sewer.

However, during normal operational conditions, the total operating time multiplied by the rated pump discharge at the given pressure head was equal to the total water usage for any unit. Vice versa, the water flow divided by the operating time resulted in the rated pump discharge at the given pressure head.

This value was used to double check the wastewater flows obtained by the two previous methods.

4) Number of Operations

As a final check on the wastewater flow values, the event recorder strip chart was used not only to summarize the total number of operations for the twelve GP units and the number of compositor operations but also to compute the approximate running time for each of the units. This data was especially useful during those days when the automatic monitoring equipment's data puncher had malfunctioned.

Simultaneous Occurrences

The Pressure Sewer Demonstration Project consisted of having 12 GP units in operation for a 12 month period. However, due to circumstances beyond our control, such as house vacancies, all 12 GP units were in actual operation for only 5½ months. The remaining time, even though all GP units were operational, some of the town houses were vacant and the GP units were not in daily use (see Table 20).

TABLE 20 - SUMMARY OF OCCUPANCY FOR 12 TOWN HOUSES

Date	No. of GP Units in Actual Usage	Remarks
Oct. 1 to Dec. 1, 1970	10	Houses No. 7 & 12 vacant
Dec. 2, 1970 to May 14, 1971	12	Total Usage
May 15 to Sept. 19, 1971	11	House No. 6 vacant
Sept. 20 to Nov. 8, 1971	10	House No. 11's prototype Unit removed from service

With the use of the 12 channel event recorder, it was possible to document (a) the total number of operations for each GP unit (b) all simultaneous occurrences (c) the precise number of GP units active during these occurrences.

This type of data is critical for the design of future pressure sewer systems. The maximum anticipated flows will dictate the size of pipe within the pressure system. At the same time, the hydraulic gradient will reach its peak slope. The engineer, therefore, must design a system optimizing the sizes and scouring velocities and be certain that the upper recommended working pressure of the GP unit is not exceeded.

Based on the event recorder data, January 4, 1971 to November 8, 1971, a summary of the total number of GP units operations and simultaneous occurrences is presented in Table 21.

During the last ten (10) months of the demonstration project, a total of 58,823 operations were recorded, which represent approximately 191 operations per day. Therefore, in order to obtain a picture of the minimum and maximum flows within the pressure system, the above mentioned data indicated that (a) on the average, 2 GP units ran simultaneously 20 times per day (b) 3 GP units operated simultaneously slightly more than once per day, and (c) 4 GP units ran simultaneously on the average of once every 14 days.

After reviewing even further the event recorder data, flows were calculated for the different reaches of the pressure main (Table 22). These flows were based on the simultaneous operations and were as follows:

1) Maximum flow for project - 60 gpm (4 GP Units)

2) Maximum Daily Flow - 45 gpm (3 GP Units)

3) Average Flow - 30 gpm (2 GP Units)

4) Minimum Flow - 15 gpm (1 GP Unit)

It should be noted that in a design of a large system which would be loaded to rated pressure (35 psig), the corresponding flows would be (4 x 11 gpm) = 44, (3 x 11 gpm) = 33, 22, and 11 gpm respectively.

Hydraulic Gradient Line

As described in Section IV, pressure gages were installed in each basement so that the maximum and minimum pressures occurring during any fifteen minute period might be recorded. These pressure readings were indicative of the varying hydraulic gradient line for each of the twelve GP units.

In reviewing the hydraulics of the system, it was decided to concentrate on the one GP unit which would be subjected to the steepest hydraulic gradient line (or the maximum operating pressure). GP unit No. 1 was the most critical unit in the system: (a) it was the most distant unit from the discharge point - 375.5 feet (114.5 meters); (b) it had the highest static head before any standpipe was erected -

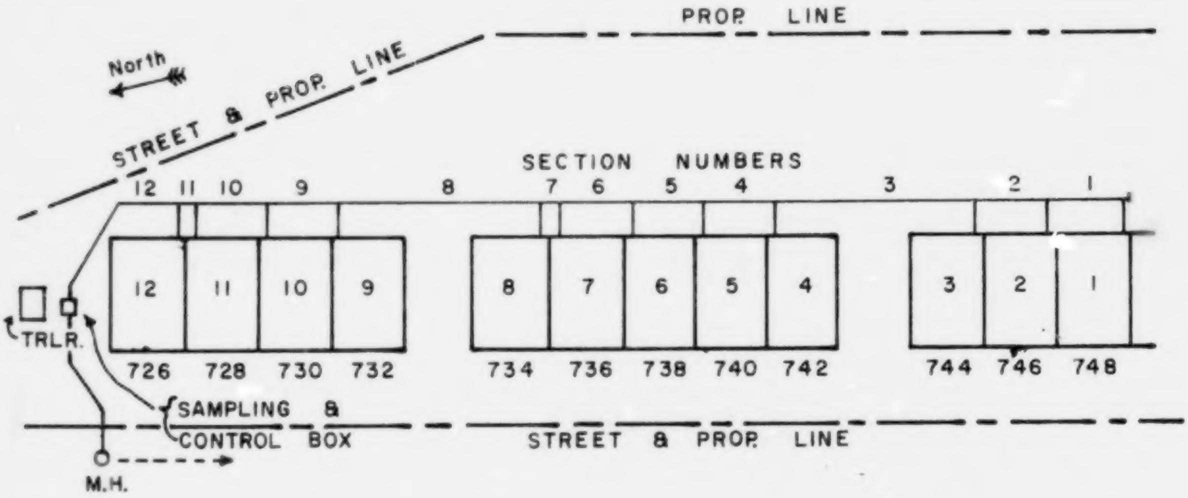
TABLE 21 - TOTAL NUMBER OF OPERATIONS AND SIMULTANEOUS OCCURRENCES

No. of GP Units Operational	Total Number of Operations 1/4/71 to 11/8/71	Simultaneous Occurrence		
		2 GP Units	3 GP Units	4 GP Units
12	37,888	4,132	268	14
11	18,523	1,911	118	4
10	2,211	191	8	3
Total	58,622	6,234	394	21

$$\text{Aver. per day} = \frac{58{,}622}{307\ \text{day}} = 191\ \text{operations/day}$$

	Occurrences per day
2-GP Units Simultaneous Operation	20
3- " " " "	1.2
4-" " " "	.07

TABLE 22
ACTUAL FLOWS FOR THE PRESSURE MAIN


PROP. LINE
North
STREET & PROP. LINE
SECTION NUMBERS
12 11 10 9 8 7 6 5 4 3 2 1
12
11
10
9
8
7
6
5
4
3
2
1
TRLR.
726 728 730 732 734 736 738 740 742 744 746 748
SAMPLING & CONTROL BOX
STREET & PROP. LINE
M.H.

SECTION NUMBER	PVC - DWV PIPE SIZE	LENGTH OF SECTION (FT)	MAX. FLOW RECORDED (GPM)	DAILY FLOWS (GPM)		
				MAXIMUM	AVERAGE	MINIMUM
1	1.25	19.7	15	15	15	15
2	2.0	20.0	30	30	30	↓
3	↓	59.2	45	↓	↓	↓
4	↓	19.2	↓	45	↓	↓
5	↓	19.5	↓	↓	↓	↓
6	3.0	19.6	↓	↓	↓	↓
7	↓	1.9	60	↓	↓	↓
8	↓	58.5	↓	↓	↓	↓
9	↓	17.4	↓	↓	↓	↓
10	↓	19.5	↓	↓	↓	↓
11	↓	2.7	↓	↓	↓	↓
12	↓	81.0	↓	↓	↓	↓

3.8 feet (1.2 meters) - and after the standpipe was erected - 17.8 feet (5.4 meters); (c) it also had the largest portion of the smallest PVC pipe (1¼" - 3.175 cm) in its system - 60 feet (18.3 meters).

The total dynamic head (TDH), that is the static head and the frictional head losses, was computed for four different flows; namely 15 gpm, 30 gpm, 45 gpm, and 60 gpm. These flows represent the full range of flows as recorded in the pressure sewer demonstration project; that is, from one GP unit up to four GP units in simultaneous operation.

There is very little information on friction losses in PVC valves and fittings. Therefore, it became necessary to use the available friction loss charts for steel valves and fittings. The PVC and steel valves and fittings are hydraulically similar, especially since both have smooth construction finish and transition points.

Moreover, computations show that of the total friction losses, approximately 32% is accounted for by valves and fittings at the maximum flow rate (60 gpm) and this percentage remains approximately the same for lower flows.

The four hydraulic gradient lines (Figure 57) are representative of the four different flows that were mentioned before. Our records indicated that the most critical hydraulic gradient line was achieved when four of the twelve units were in simultaneous operation. Those units were Nos. 1, 2, 3 and 7.

Based on the computations of the hydraulic gradient line for Unit No. 1, we can examine the pressure gage readings in relationship to the total dynamic head of the GP units. Since the pressure gages were located approximately 5 to 10 feet from the GP units on the 1¼" PVC discharge pipe, the pressure readings reflected only a certain percentage of the total dynamic head (TDH). During the maximum flow, the pressure readings were equivalent to 63% of the theoretical TDH and, at minimum flow, these values corresponded to only 40% of the theoretical TDH.

Therefore, in effect, at maximum flow, the theoretical TDH was equivalent to 15.57 feet (6.75 psi). But, the pressure gages should have registered a theoretical computed value of 9.81 feet (4.25 psi).

During the demonstration project, there were three specific static head changes introduced into the system. First, on February 16, a five (5) foot stand pipe (3" PVC) was erected at the discharge end so that the total flow could be diverted to the compositor (described in in Section VIII). Approximately 8 feet of 3" PVC pipe was added with two (2) 90° medium elbows. This modification added an additional 5.5 feet to the TDH at the maximum flow.

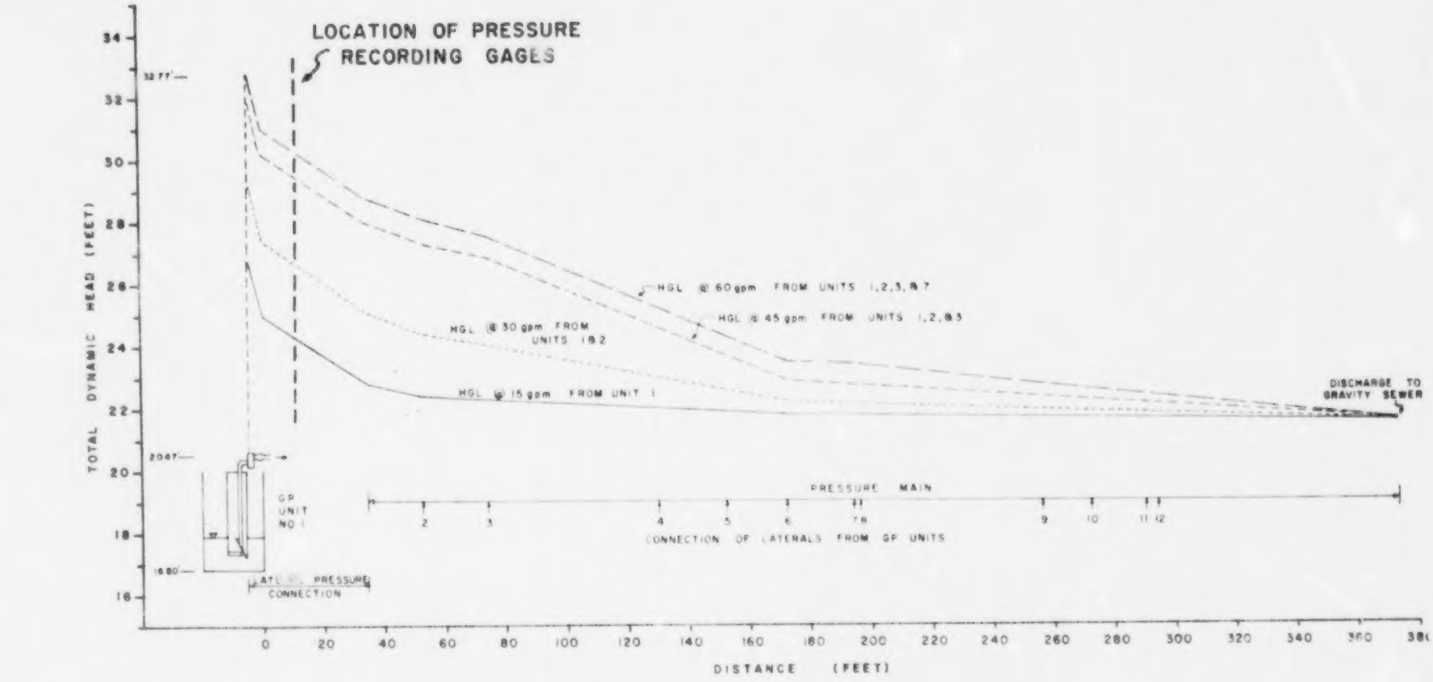


FIGURE 57 HYDRAULIC GRADIENT LINES FOR PRESSURE SEWER SYSTEM
(BEFORE MODIFICATIONS)

Further additions were incorporated into the system on August 12 and September 10. This amounted to modifying the stand pipe by an additional 5 feet and 4 feet respectively, resulting in an increase of the TDH of 10.4 feet (4.51 psi) and 14.5 feet (6.29 psi) on those two dates.

One final change was made on September 23 at which time the discharge end of the pressure main was reduced from 3" to 2" for the purpose of increasing even further the TDH.

Therefore, the TDH after September 23 was computed to be a theoretical 31.07 feet (13.5 psi) (Figure 58). This does not correspond exactly to the actual readings printed by the computer on the daily summary sheets. However, there are two possible explanations for these inaccuracies. One, we had preliminary indications that, due to the overdesigning of the pressure main, grease accumulations were reducing the inside area of the main. What was not known was the extent of the grease accumulations. Secondly, the pressure gages were not 100% operational for the duration of the project. As reported before (Section IV), clogging of the brass instrument check valves was extensive. Therefore, when the data was analyzed, we did not know what confidence level to place on these pressure readings.

When the new stainless steel instrument check valves were installed with an oil barrier between the gages and the wastewater, an immediate spot check on their operation indicated that, on the average, most of them were performing satisfactorily. Again, because of the small diameter copper tubing used to connect the gages to the 1¼" PVC discharge pipe, it is not known whether clogging was again affecting the final pressure readings.

Solids Accumulation Within Pressure Pipes

Once the demonstration phase of the project was completed, portions of the pressure main and the 1¼ inch pressure laterals were carefully excavated and removed. This was necessary to document any existing accumulations within the PVC pipes and to record any possible exterior deterioration due to direct pipe burial since PVC is a relatively new product and extensive performance records are limited.

A pipe sample was uncovered for each of the twelve pressure laterals just outside the foundation walls and, in addition, pressure main samples were excavated and removed as indicated in Figure 59.

Likewise, pipe samples of the 1¼ inch PVC discharge pipe located inside each basement were removed, documented and photographed in order to note whether a more constant ambient temperature had any different effect on the grease or solids accumulations within the pipe.

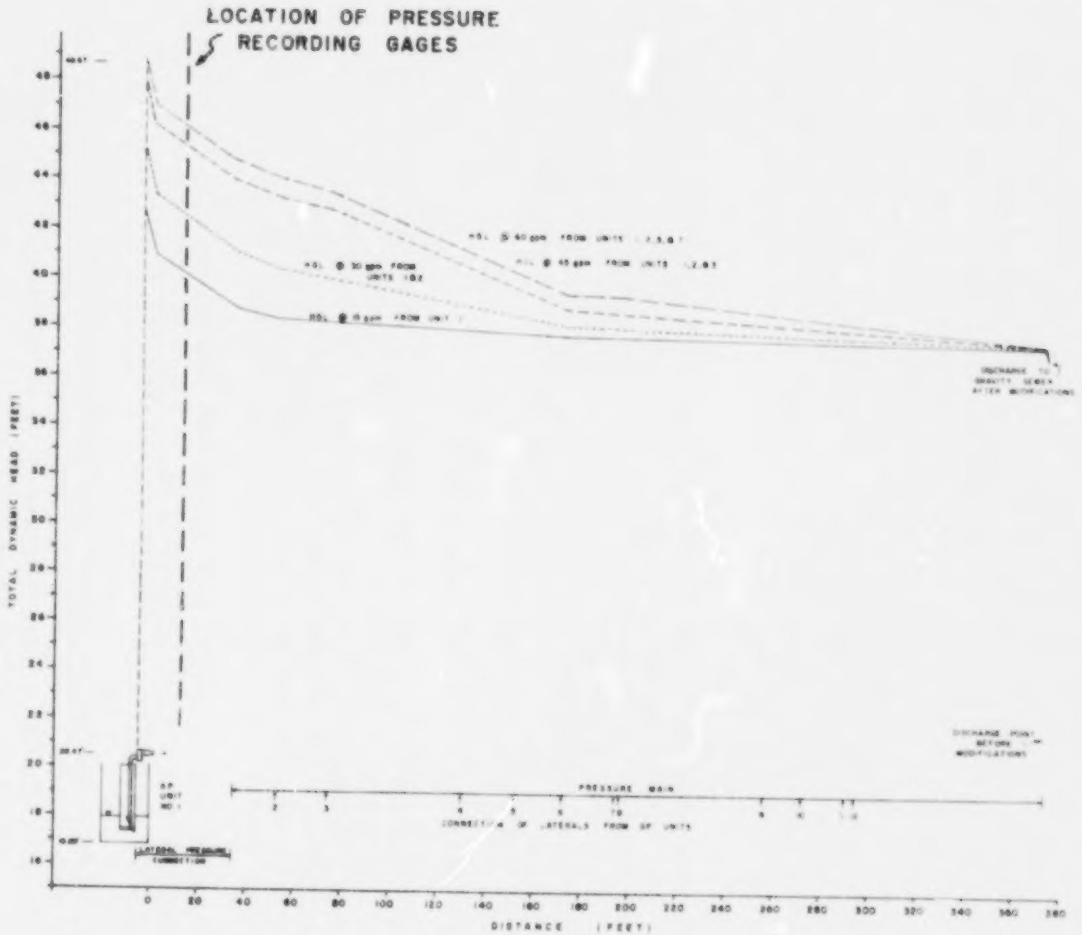


FIGURE 58

HYDRAULIC GRADIENT LINES
FOR PRESSURE SEWER SYSTEM
(AFTER MODIFICATIONS)

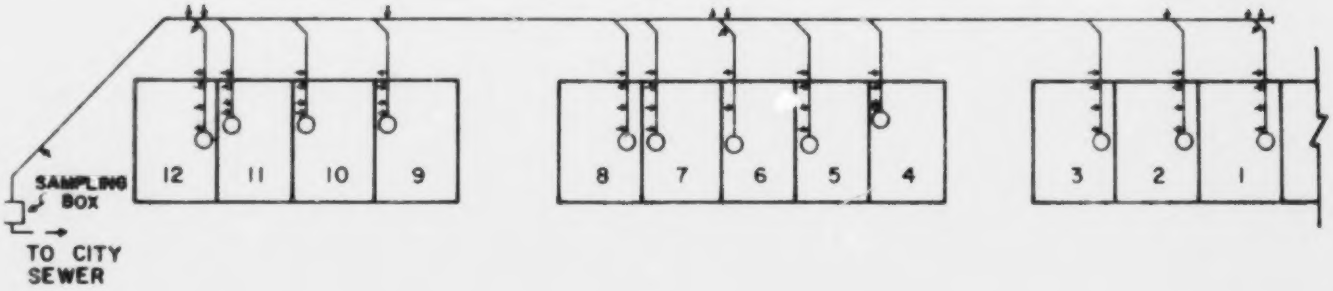

SAMPLING BOX
TO CITY SEWER
12
11
10
9
8
7
6
5
4
3
2
1

FIGURE 59

LOCATIONS OF 58 EXCAVATED PORTIONS
FROM PRESSURE MAINS
AND LATERALS

Because the pressure main was over-designed, the grease accumulations were quite extensive on the upper portion of the pipe with no solids accumulations on the lower portion (Figures 60 and 61).

All of the pipe samples were immediately photographed. Afterward, these same samples were carefully cross-sectioned so that by using thin paper, the exact inside area was traced. Using a Planimeter, the cross-sectioned area of the grease accumulation was calculated and, at the same time, the percentage of area reduction was tabulated (Tables 23 and 24).

Conclusions

The PVC Type I Schedule 40 pipes and PVC-DWV fittings used throughout the pressure sewer system were relatively easy to install but somewhat more difficult to repair. There was no noticeable outside damage or deformation in any of the PVC pipes which were excavated at the conclusion of the project. The eighteen inches of sand cover protected the pipes well.

The wastewater flows were computed based on total GP units operating time, the total number of GP units operations, and the number of compositor operations. These three sources confirmed what was originally assumed; that is, that the water flow within the house is approximately equivalent to the wastewater flow. Since the water and wastewater flow data, barring any excessive outside water usage, showed close relationship existing between the two (Figure 54), winter water flow records for a given area can be used to estimate accurately the expected wastewater flows and total operational usage of the GP units.

A major problem in designing a pressure sewer system consisting of a multiple number of GP units will be the sizing of the pressure main, which is directly dependent on the estimated maximum number of GP units operating simultaneously within that system. We have shown that our original assumptions for this twelve unit system were far from being accurate. Therefore, estimated flows did not materialize, resulting in velocities lower than the recommended scouring velocities for solids(22). There are no existing standards for velocities dealing with the grease accumulation problem, even though velocities in the range of 2 fps to 8 fps(24) have been used by some in designing wastewater pressure conduits. However, for a pressurized sewer system utilizing GP units, a velocity range of 2 fps to 5 fps is hydraulically and economically preferable.

Our data, limited to a great extent due to the small number of GP units in operation, did show that, in a twelve unit system, only a maximum of four units operated simultaneously for the duration of the project. The pressure sewer system project data combined with data already published(25) and with statistical computations performed by others(26), can be used to project the expected number of GP units working concurrently in a large-scale pressure sewer system.

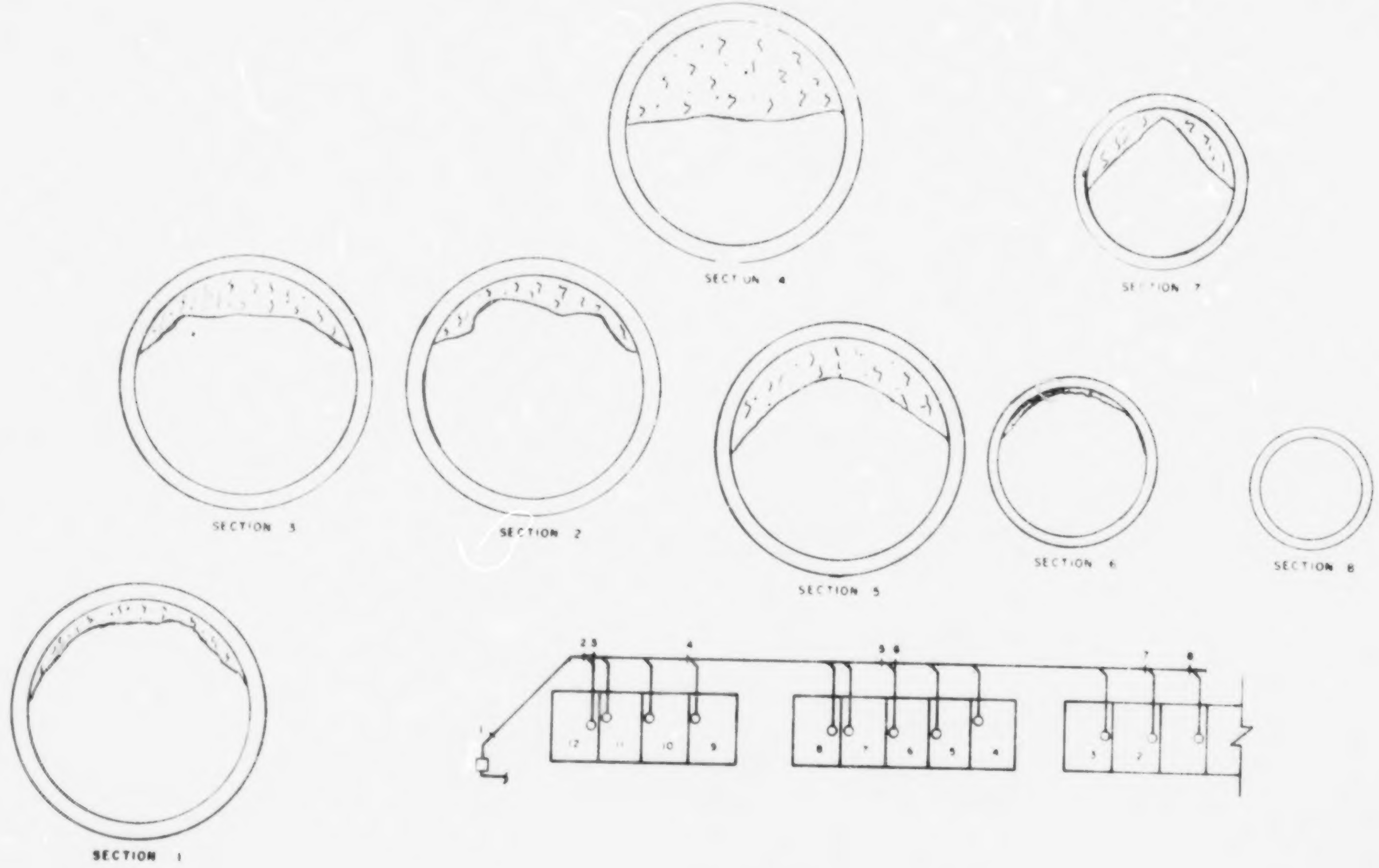

SECTION 4
SECTION 7
SECTION 3
SECTION 2
SECTION 5
SECTION 6
SECTION 8
SECTION 1
1
2 3
4
5 6
7
8
12
11
10
9
8
7
6
5
4
3
2

FIGURE 60

GREASE ACCUMULATION WITHIN PRESSURE SEWER MAIN

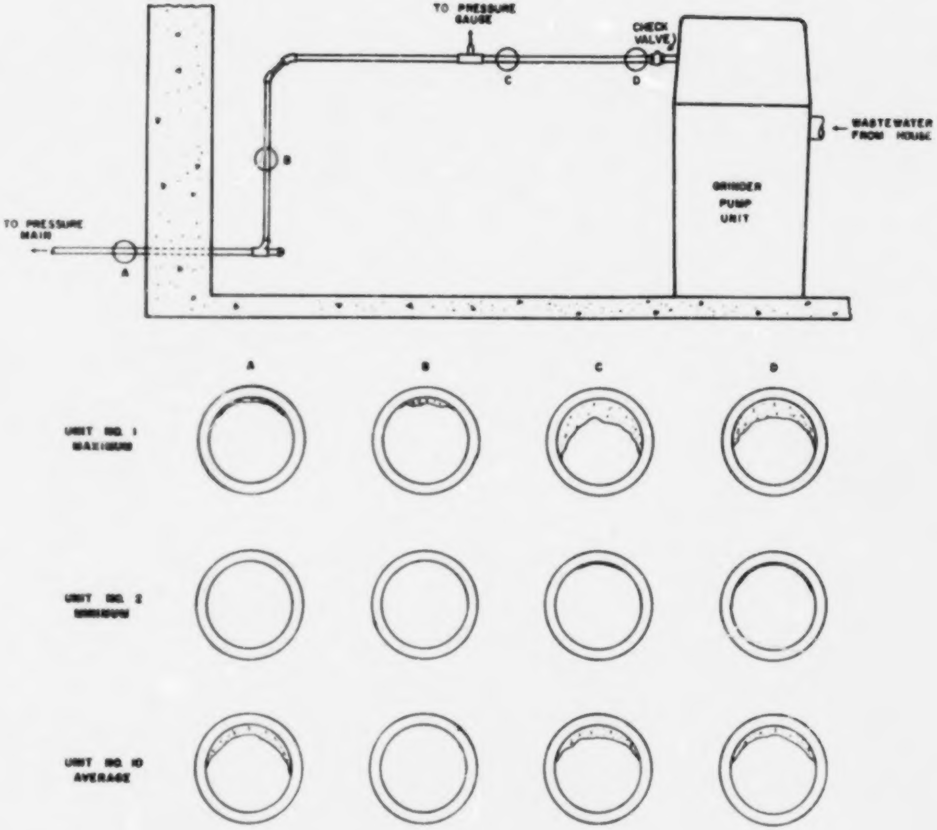

TO PRESSURE MAIN
A
B
TO PRESSURE GAUGE
C
D
CHECK VALVE
GRINDER PUMP UNIT
WASTEWATER FROM HOUSE
A
B
C
D
UNIT NO. 1 MAXIMUM
UNIT NO. 2 MINIMUM
UNIT NO. 10 AVERAGE

FIGURE 61
GREASE ACCUMULATION IN PRESSURE LATERALS

TABLE 23

CROSS-SECTIONAL AREA REDUCTIONS FOR PRESSURE MAIN

Location #	Original Pipe Size (in)	Original Inside Area (in^2)	New Inside Area (in2)	% Reduction
1	3	7.38	6.51	11.8
2	3	7.38	6.37	13.7
3	3	7.38	6.03	18.3
4	3	7.38	4.41	40.2
5	3	7.38	5.77	21.8
6	2	3.34	3.17	5.1
7	2	3.34	2.51	24.3
8	1¼	1.47	1.47	0

TABLE 24

CROSS-SECTIONAL AREA REDUCTION FOR THE 1¼" PVC PRESSURE LATERALS

Location*	Original Pipe Size	Original Inside Area (in^2)	New Inside Area (in^2)	% Reduction
GP No.1-A	1¼	1.47	1.05	28.6
A	"	"	0.84	42.9
A	"	"	0.93	36.7
B	"	"	1.41	4.1
C	"	"	1.40	4.8
GP No.2-A	1¼	1.47	1.47	0
A	"	"	"	"
B	"	"	"	"
C	"	"	"	"
GP No.3-A	1¼	1.47	1.38	6.1
A	"	"	1.30	11.6
B	"	"	1.47	0
B	"	"	1.47	0
C	"	"	1.37	6.8
GP No.4-A	1¼	1.47	0.87	40.8
B	"	"	1.47	0
C	"	"	1.39	5.4
GP No.5-A	1¼	1.47	1.42	3.4
A	"	"	Slight	Slight
B	"	"	1.47	0
C	"	"	1.43	2.7
GP No.6-A	1¼	1.47	1.03	29.9
C	"	"	1.42	3.4
GP No.7-A	1¼	1.47	1.40	4.8
A	"	"	1.37	6.8
B	"	"	1.47	0
C	"	"	1.37	6.8
GP No.8-A	1¼	1.47	1.21	17.7
A	"	"	0.96	34.7
B	"	"	1.47	0
C	"	"	0.87	4.1

TABLE 24 (Continued)

Location*	Original Pipe Size	Original Inside Area (in^2)	New Inside Area (in^2)	% Reduction
GP No. 9-A	1¼	1.47	1.15	21.8
A	"	"	1.26	8.5
B	"	"	1.47	0
C	"	"	1.39	5.4
GP No. 10-A	1¼	1.47	1.27	13.6
A	"	"	1.27	13.6
B	"	"	1.47	0
C	"	"	1.19	19.0
GP No. 11-A	1¼	1.47	1.26	8.5
A	"	"	1.23	16.3
A	"	"	1.37	6.8
B	"	"	1.40	4.8
C	"	"	1.42	3.4
GP No. 12-A	1¼	1.47	1.32	10.2
A	"	"	1.14	22.4
A	"	"	1.14	22.4
A	"	"	1.31	10.9
A	"	"	1.39	6.1
B	"	"	1.47	0
B	"	"	1.47	0
C	"	"	1.10	25.2

* A - Horizontal section inside town house
* B - Vertical section inside town house
* C - Horizontal section outside town house

By predicting the maximum number of units operating simultaneously, the expected maximum flow within a system will then dictate the size of the pressure pipes. In case a slightly higher number of units than anticipated were to operate simultaneously, there would be no adverse effect on the system. The efficiency of the pump would be somewhat reduced; that is, the discharge rate would be decreased and the input power increased as shown in Figure 29. However, since the normal operating time of the GP units is approximately one minute, this critical condition would be short-lived with minimal effects on the life of motor and pump. Additionally, the units are protected from damaging long-term overloads by automatic reset thermal protectors.

Also, in reviewing the data on the pipe samples from the pressure main, the percentage of area reduction due to grease accumulation was plotted in relationship to its location on the pressure main. For the 3" pressure pipe, five samples of pipe were removed and the results (Figure 62) seemed to indicate that the section of the pressure main with the highest usage (or serving the greater number of GP units) had the least amount of grease accumulation. Even though the point is extremely high, we believe that our statement holds true especially when the 2" sections of pressure main were examined. It must be understood that this was a relatively short pressure main and we only had a limited number of pipe sample values available. However, it was recorded, at least on one occasion when samples for chemical analysis were being taken, that a large piece of the grease accumulation had been discharged at the effluent. It was removed from the concrete tank and measured. From its smooth rounded contour on the one side, we concluded, at that time, that this particular piece of grease accumulation came from some point in the 3" section of the pressure main.

With the additional evidence obtained upon removal of different sections of the pressure main, it can be concluded that, due to overdesign of the piping system, grease accumulated within the pipe until an equilibrium was reached. At this point, the increased velocities within the different reaches of the pressure main kept any further grease accumulations from occurring. If grease did accumulate extensively within a certain section of the pressure main, then during one of the infrequent occurrences of the extremely high peak flows, the accumulation would be reduced or scrubbed entirely free from adhering to the top portion of the pipe.

Now, by knowing the extent of the grease accumulations, the pressure gage readings were plotted for Unit No. 2 for the entire demonstration period (Figure 63). Since the GP units were in operation for three months prior to the actual start of the demonstration, this was ample time for grease to accumulate within the pressure system.

Therefore, on October 1 and thereafter, the pressure readings should have reflected the grease accumulation within the pipes. For instance, the computation of the hydraulic gradient line indicated that a peak

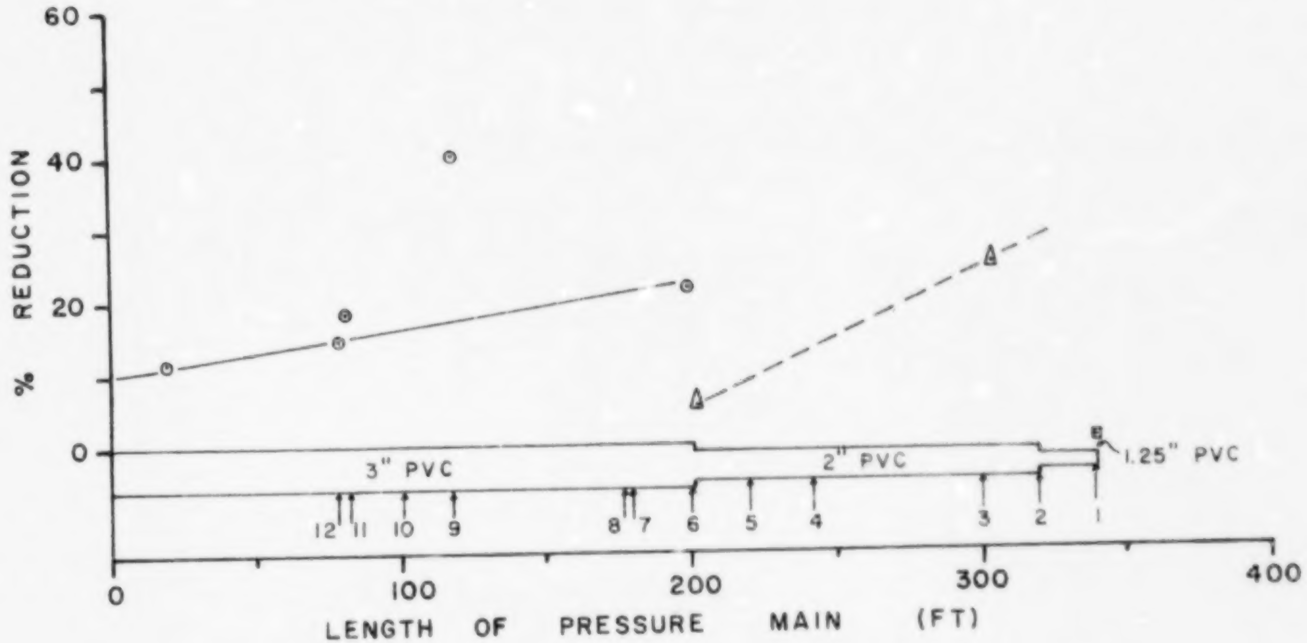


FIGURE 62 PERCENT REDUCTION OF CROSS-SECTIONAL AREA WITHIN THE PRESSURE MAIN

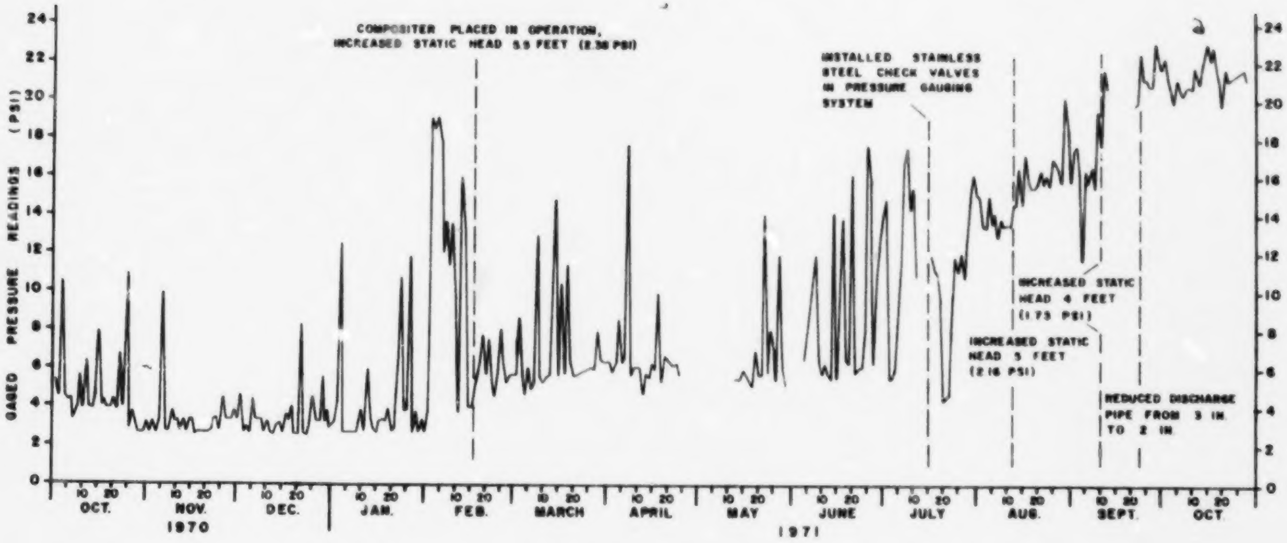


FIGURE 63

GAGED PRESSURE READINGS FOR UNIT NO. 2

pressure of 5.33 psi should have occurred between October 1, 1970 and February 15, 1971. However, the printouts show peak readings of 12 psi during this same period, leading us to believe that a sizeable reduction of the cross-sectional area of the pressure pipe had taken place. On the average, however, the pressure readings were within the computed values.

On February 16, as reported previously, the TDH was increased by 5.4 feet (2.34 psi). This increase is reflected in the pressure readings as shown in Figure 63. With further modification of the system, the computed TDH reached a maximum of 31.07 feet (13.5 psi) of which 26.82 feet (11.62 psi) should have been registered by the pressure gages in Unit No. 1. The computer printouts showed that pressures in excess of 29 psi were registered by this same unit.

The difference between the recorded and computed values can be accounted for by the decrease in the cross-sectional area due to grease buildup. A new TDH was computed using the reduced cross-sectional area within the pipe from GP Unit No. 1 to the discharge point. We arrived at a value of 53.99 feet (23.40 psi) which was based on friction losses through smooth pipe, which were equivalent to the reduced area of the different sections of the pressure sewer system. As can be seen in the cross-sectional diagrams, the grease accumulation was far from being smooth. Therefore, it was concluded that the pressure readings, as high as they were, were justified by our theoretical computation of the TDH, especially if a roughness factor is included to account for the uneven grease buildup within the pressure pipes.

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SECTION VIII

CHEMICAL SAMPLING RESULTS

Introduction

A stated objective of the Pressure Sewer System Demonstration Project was to characterize by physical and chemical analysis the wastewater produced by a pressure system and draw conclusions on what, if any, differences result from collection and transporting of wastewater via the proposed pressure system when compared to a gravity system(11). To meet this objective, the analytical program shown in Table 25 was planned and implemented.

Methods and Procedures

The pressure sewer system demonstration site consisted of twelve individual, single family homes connected to a pressure main via grinder-pump (GP) units. The pressure main was 102.9 meters (337.5 feet) long and finally discharged into a conventional gravity sewer system manhole. A schematic of the system as installed is given in Figure 47. The pressure sewer system and the GP unit are described in detail in Sections IV and V.

Wastewater flows were calculated using water use data, the operating records of the GP units, and a composite sampler, all of which were recorded automatically. The data collection system and computational procedures used to calculate wastewater flows are also described in Section VII.

Detailed census of home occupancy and other information related to wastewater production was collected through personal interviews utilizing a pre-designed form (Appendix A).

In order to obtain a representative daily composite sample, a device which composited according to flow was constructed. The device shown diagrammatically in Figure 64 consisted of a tank, a stirrer, three pinch-tube valves and three variable timers. Figure 65 is a photo of the actual compositor. Referring to Figure 64and the wiring diagram in Figure 66, a normal sequence of operation was as follows:

1. At the start of a cycle, the compositing tank is empty and all valves are closed. All wastewater from the pressure sewer system flows into the compositing tank.

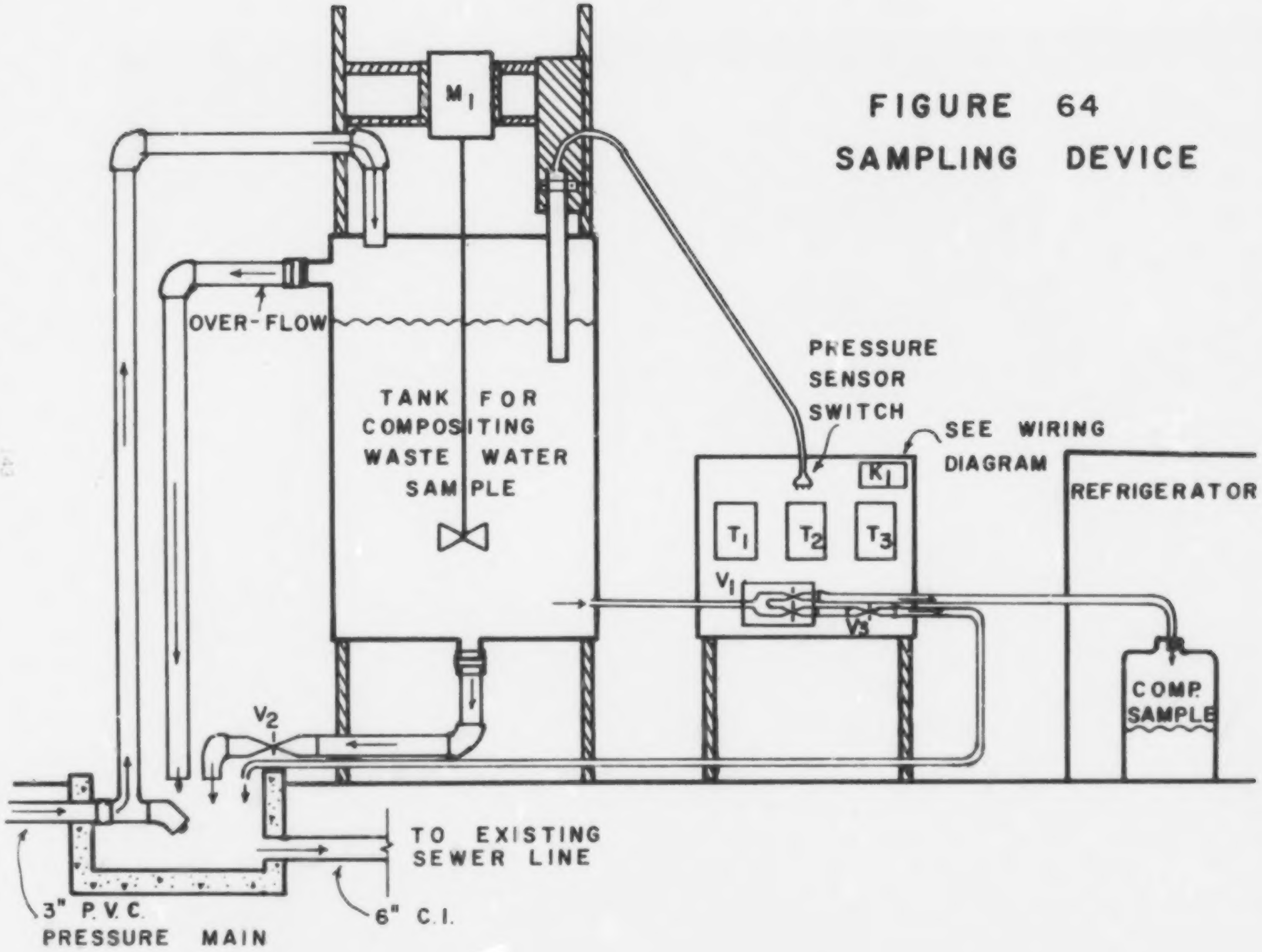
2. When the level of wastewater in the tank reaches a preset level (volume = 545 liters), a pressure sensor switch activates Timer #1.

3. Timer #1 immediately activates the mixer (M_1) and opens pinch valve #3, thereby mixing the contents of the compositing tank and flushing the sampling line.

TABLE 25 - ANALYTICAL PROGRAM

Date	Number of Samples	Type of Samples	Analysis
12/2/70 to 2/11/71	27	Grab	pH, BOD_5, COD, Total Phosphorus, Particulate Phosphorus, Dissolved Phosphorus, Ortho-phosphorus, Ammonia, Organic Nitrogen, Nitrate, Nitrite, Hardness, Chlorides, Detergent (MBAS as LAS), Total Solids, Volatile Solids, Fixed Solids, Total Suspended Solids, Volatile Suspended Solids, Fixed Suspended Solids, Total Dissolved Solids, Volatile Dissolved Solids, Fixed Dissolved Solids, Grease, Settleable Matter (1/2 hr., 1 hr., 2 hrs.)
2/17/71 to 4/14/71	56-70	Composite	pH, BOD_5, COD, Total Phosphorus, Particulate Phosphorus, Dissolved Phosphorus, Ortho-Phosphorus, Ammonia, Organic Nitrogen, Nitrate, Nitrite, Hardness, Chlorides, Detergent (MBAS as LAS), Total Solids, Volatile Solids, Fixed Solids, Total Suspended Solids, Volatile Suspended Solids, Fixed Suspended Solids, Total Dissolved Solids, Volatile Dissolved Solids, Fixed Dissolved Solids, Grease, Settleable Matter (1/2 hr., 1 hr., 2 hrs.)
3/23/71 to 4/14/71	19	Grab	Sulfides
4/20/71 to 4/21/71	25	Grab	Sulfides
4/29/71 to 5/21/71	12	Grab	Settleability Study

FIGURE 64
SAMPLING DEVICE



M_1
OVER-FLOW
TANK FOR COMPOSITING WASTE WATER SAMPLE
PRESSURE SENSOR SWITCH
SEE WIRING DIAGRAM
K_1
T_1
T_2
T_3
V_1
V_3
V_2
REFRIGERATOR
COMP. SAMPLE
TO EXISTING SEWER LINE
6" C.I.
3" P.V.C. PRESSURE MAIN

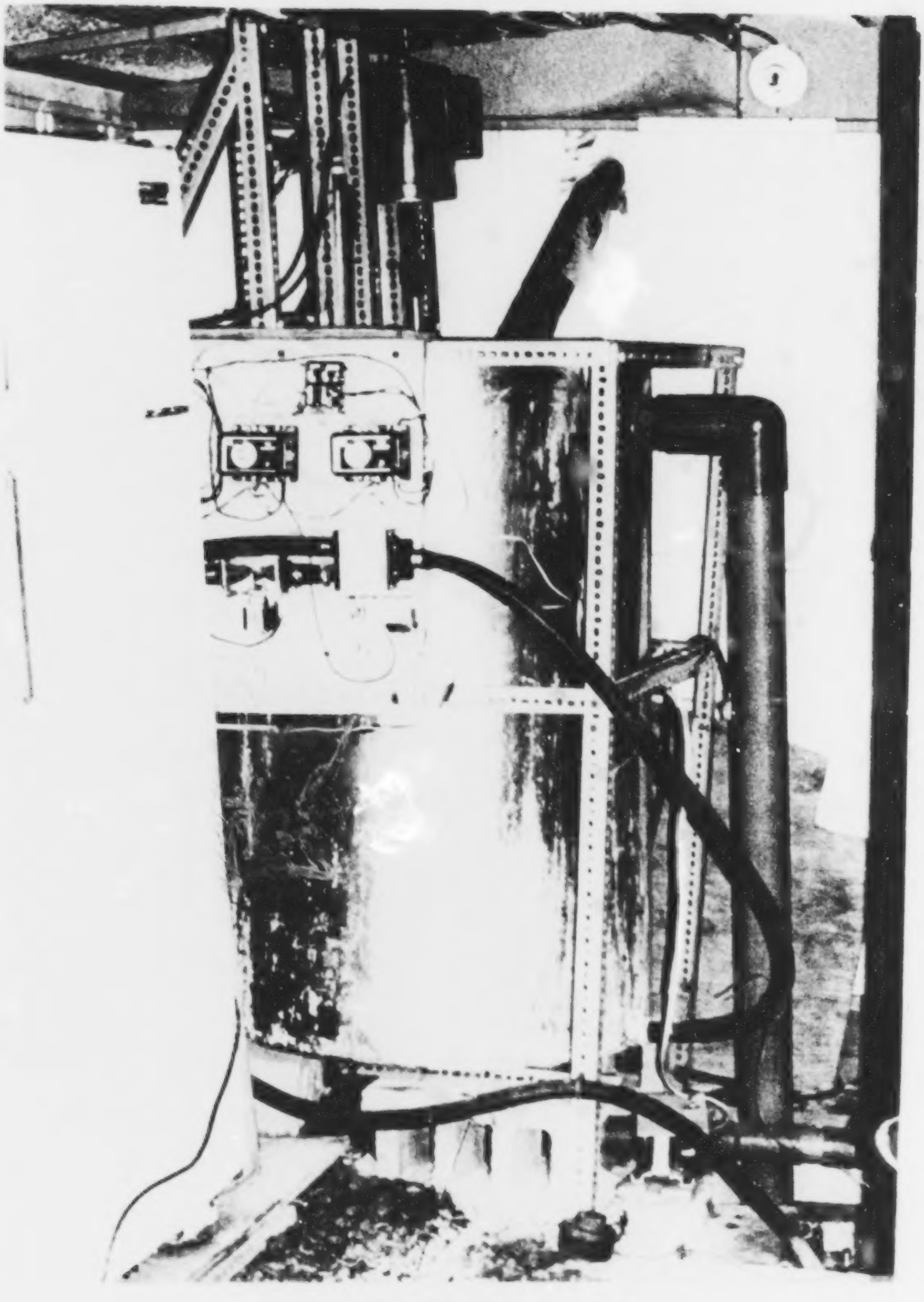
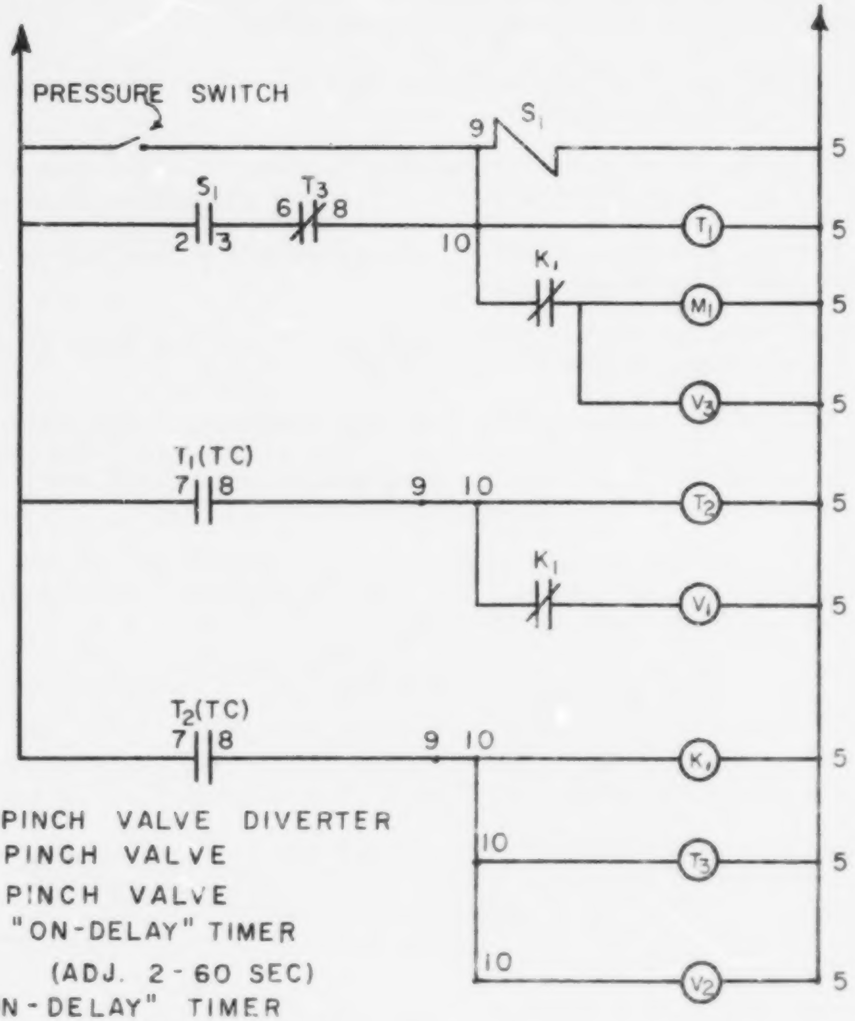


FIGURE 65

PHOTOGRAPH OF COMPOSITOR

ELECTRIC CONNECTIONS - WASTE WATER SAMPLING SYSTEM


PRESSURE SWITCH
9
S_1
5
S_1
2
3
T_3
6
8
10
T_1
5
K_1
M_1
5
V_3
5
T_1(TC)
7
8
9
10
T_2
5
K_1
V_1
5
T_2(TC)
7
8
9
10
K_1
5
10
T_3
5
10
V_2
5

V_1 1" PINCH VALVE DIVERTER
V_2 2" PINCH VALVE
V_3 1" PINCH VALVE
T_1, T_2 "ON-DELAY" TIMER
(ADJ. 2-60 SEC)
T_3 "ON-DELAY" TIMER
(ADJ. 10-300 SEC)
K_1 DOUBLE POLE, DOUBLE THROW RELAY
-||- CONTACT - NORMALLY OPEN
-|/|- CONTACT - NORMALLY CLOSED
M_1 1 H.P. MOTOR

FIGURE 66

4. After fifty seconds, Timer #1 activates Timer #2 and closes pinch valve #3.

5. Timer #2 opens valve #1, thereby letting an aliquot of the compositing tank flow into the refrigerated sampling bottle. After five seconds, pinch valve 1 is closed and Timer #3 activated.

6. Timer #3 opens valve 2 for 165 seconds (slightly more than the time required to completely empty the tank) and the contents of the tank are emptied into the gravity sewer system.

7. All valves are closed and switches returned to their normal position and the cycle begins again.

Using the above, an aliquot of wastewater is taken from the tank each time it fills. Since the rate at which the tank fills and empties is proportional to the wastewater flow, the contents of the refrigerated sampling bottle after any period of time represents a true flow proportional composited sample.

The system cycled approximately 18 times per day. A bar graph of the number of operations is shown in Figure 67.

The contents of the sample bottle thus composited were collected and a suitable aliquot filtered with a 0.8 µ filter at the site. The samples were then delivered to the laboratory each morning and kept refrigerated until the analyses were performed (usually the same day).

Grab samples were also brought directly to the laboratory and kept under refrigeration until the analyses were performed (usually the same day). Sulfite samples were fixed at the site.

All samples for grease were grab samples because of the difficulties with build-up within the sampler.

The analytical methods used, their precisions and the instruments utilized are shown in Table 26.

The vanadomolydophosphoric acid method performed on a sulfuric/nitric acids digestate was the method chosen for the determination of total phosphates. This resulted in relative freedom from salinity error as well as satisfactory precision and good recovery (104% from diphosphopyridine nucleotide, reduced).

The Orion sulfide specific electrode was used for the analysis of total sulfides. Samples were diluted on site 1:1 with a salicylateascorbate antioxidant buffer. Analyses were usually performed on the day of sample collection.

The chemical oxygen demand test was performed according to the Thirteenth Edition of "Standard Methods"(27). The strength of the samples required the use of 0.25 normal potassium dichromate as an oxidant.

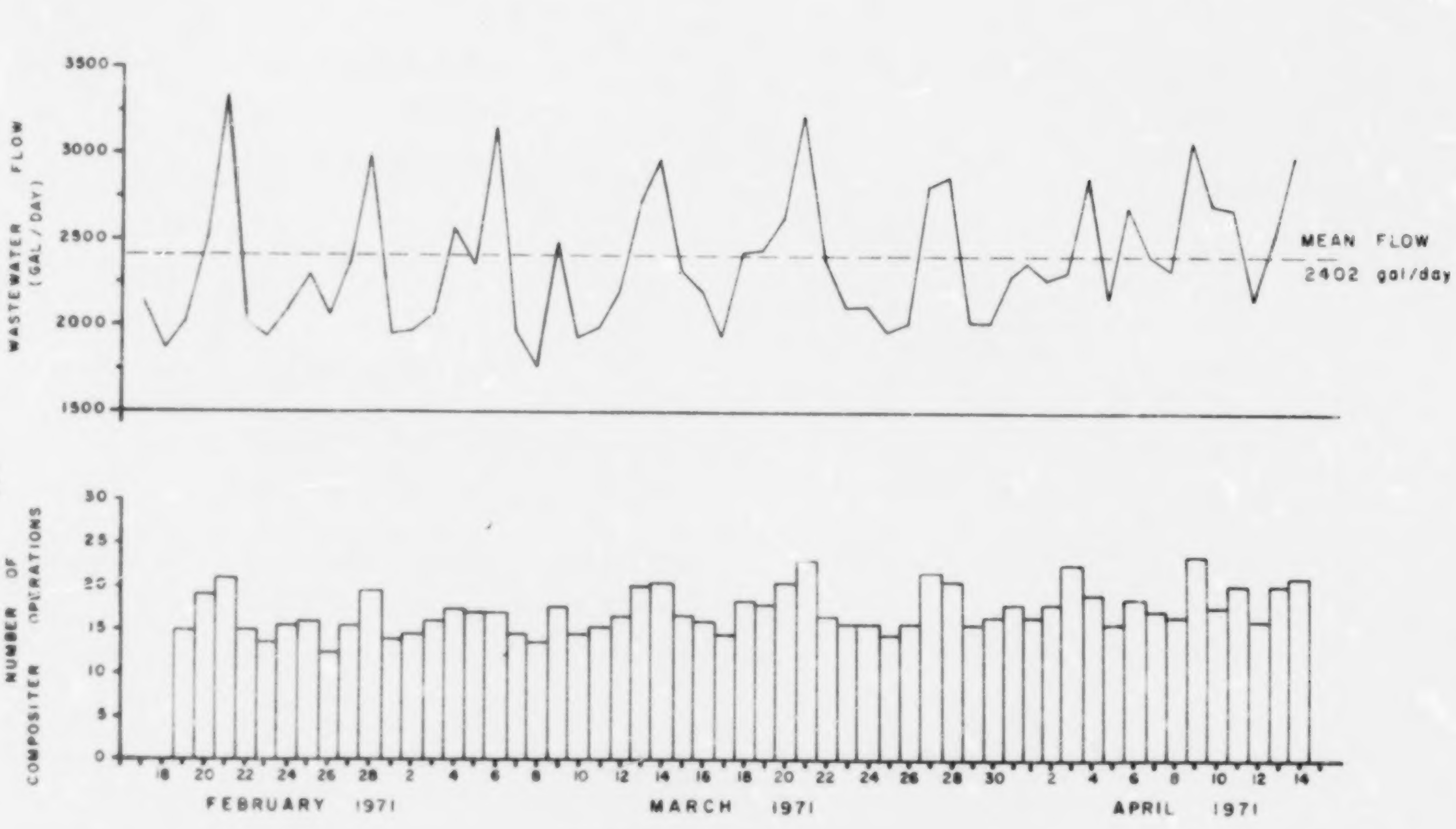


FIGURE 67

WASTEWATER FLOW AND COMPOSITOR OPERATIONS

TABLE 26

ANALYTICAL METHODS UTILIZED

Analysis	Method	Instrument	Precision % RSD	Precision Conc.	References
Nitrate	Reduction to nitrite followed by sulfanilic acid diazotization and formation of AZO-DYE	Technicon Auto-Analyzer	4	0.5 mg/l	28
Nitrite	Colorimetric-Sulfanilic acid diazotization followed by formation of AZO-DYE	Bausch and Lomb Spectronic 400	12	0.25mg/l	29
Total Phosphate	Wet ashing by sulfuric and nitric acids and reaction of orthophosphate with vanadate and molybdate to form vanadomolydophosphoric acid	Bausch and Lomb Spectronic 400	7	10 mg/l	27
Orthophosphate	Colorimetric formation of vanadomolydo-phosphoric acid	Bausch and Lomb Spectronic 400	9	7 mg/l	27
Chlorides	Complexation of mercury by chloride resulting in the release of thiocyanate. Reaction of thiocyanate with ferric iron to form ferric thiocyanate	Technicon Auto-Analyzer	0.3	100mg/l	31
Total Sulfides	Ion specific electrode	Orion sulfide-specific electrode and Orion Model 407 Specific Ion Meter	1.2	16 mg/l	30
pH	Electrometric	Beckman "Zeromatic" pH meter	1.0	pH 7.0	27
BOD_5	Bottle dilution-DO by the Alsterberg modification of the Winkler method		17	184mg/l	27
COD	Dichromate consumption		6.5	100mg/l	27
Free Ammonia	Direct Nesslerization	Visual Comparison	5.3	1.5mg/l	27

TABLE 26 (continued)

Analysis	Method	Instrument	Precision % RSD	 Conc.	References
Organic Nitrogen	Kjeldahl method-collection of ammonia under boric acid followed by titration with standard sulfuric acid		55	1.5mg/l	27
Hardness	EDTA titration using eriochrome black T indicator		2.9	610mg/l	27
Surfactants	Colorimetric methylene blue method. Read against standard linear alkyl sulfonate	Bausch and Lomb Spectronic 400	14.8	0.27mg/l	27
Total and Suspended Solids	Gravimetric		5.0	0.08mg/l	27
Grease	Gravimetric-Soxhlet extraction		2.0	120mg/l	27

Ferrous ammonium sulfate made to be 0.25 normal and standardized against 0.25 normal dichromate was used as the titrant.

Settleability tests were carried out as follows:

1. Grab samples were taken each morning on the dates and at places listed. Approximately 12 gallons of samples were taken.
2. Samples were transferred to an 8 foot settling column 6 inches in diameter.
3. The solids were kept in suspension by introducing air at the bottom of the settling column.
4. The air supply was discontinued and the contents of the column were allowed to stabilize for 5 minutes.
5. A 10 ml sample was taken at each sampling port after this initial five minute time period. This was considered as Time = 0 min.
6. Samples were then taken at the indicated time intervals.
7. Suspended solids determination was made for each sample.

Results

The Homes and Their Occupants -

The combined population served by the system was 75 people, 70% of whom were children. The homes were individually owned; however, the median income of the occupants was low since the combined income of each family had to be less than $7,500 for them to qualify to purchase a home in the project area.

Data collected on occupancy and other information related to wastewater production is summarized in Table 2.

Wastewater Flows -

A detailed analysis of the measured flows was made using water meter readings, GP data and the sample compositing device operational data. These results, the details of which have been presented in Section VII, are summarized in Table 27.

Chemical Quality -

Over a five month period of time, over 25 grab and 55 composite samples were collected and analyzed. The raw data which resulted from this program is given in Appendix F. Table 28 summarizes the composite sample data as to means and variations found. Figures 68 through 74 present the results graphically.

TABLE 27

WASTEWATER FLOWS

	Average Over Compositing Period		Average Over Demonstration Period	
	Daily Total	Gal/Cap/Day	Daily Total	Gal/Cap/Day
Mean Flow	2402	32.0	2807	37.4
Maximum Flow	3311	44.1	3636	48.5
Minimum Flow	1783	23.8	1566	20.9

TABLE 28

SUMMARY OF COMPOSITE SAMPLE ANALYTICAL RESULTS

Parameter	Number of Samples	Mean*	Standard Deviation	Minimum Value	Maximum Value
5 Day Biochemical Oxygen Demand	57	330	53	216	504
Chemical Oxygen Demand	56	855	158	570	1450
Soluble Total Organic Carbon	6	140	49	21	225
Total Solids	55	681	87	526	928
Total Volatile Solids	56	476	84	336	706
Total Fixed Solids	56	205	63	57	355
Total Suspended Solids	56	310	77	138	468
Volatile Suspended Solids	56	274	84	78	440
Fixed Suspended Solids	56	36	48	0	268
Total Dissolved Solids	55	372	90	195	637
Volatile Dissolved Solids	55	201	62	22	372
Fixed Dissolved Solids	55	171	58	27	353
Organic Nitrogen**	53	29	12	7	76
Ammonia Nitrogen**	54	51	9	34	68
Nitrate Nitrogen**	38	0.1	-	--	--
Total Phosphate***	63	15.9	6.3	7.2	49.3
Particulate Phosphate***	50	2.6	0.9	0.4	4.2
Filterable Phosphate***	51	13.1	6.5	5.2	47.9
Total Ortho Phosphate***	32	8.7	3.9	1.3	17.9
Methylene Blue-Active Substances****	39	12.4	4.5	4	24
Grease	9	81	12.3	31	140
Settleable Matter ½ hr.	56	14.5	6.1	4	37

TABLE 28 (Continued)

Parameter	Number of Samples	Mean*	Standard Deviation	Minimum Value	Maximum Value
Settleable Matter 1 hr.	56	15.0	6.2	4.5	38
Chlorides	38	52	4	41	61
Hardness	55	65	7.4	46	90
Alkalinity	9	198	8.1	185	209
pH	54	7.8	.3	7.1	8.7

* All values expressed as mg/l except pH
** As nitrogen
*** As phosphorus
**** As linear alkylate sulfonate

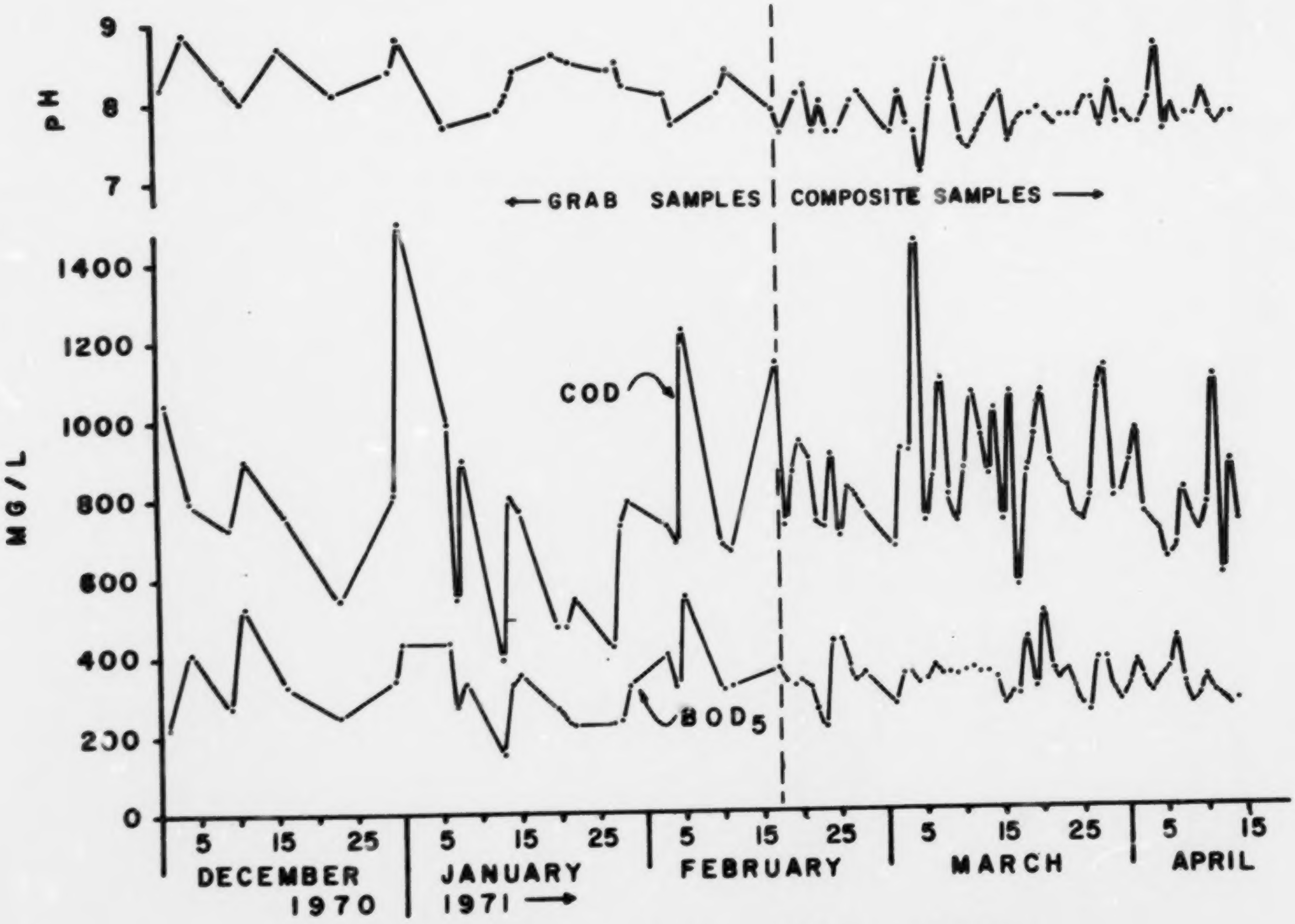


FIGURE 68 pH, COD, BOD_5

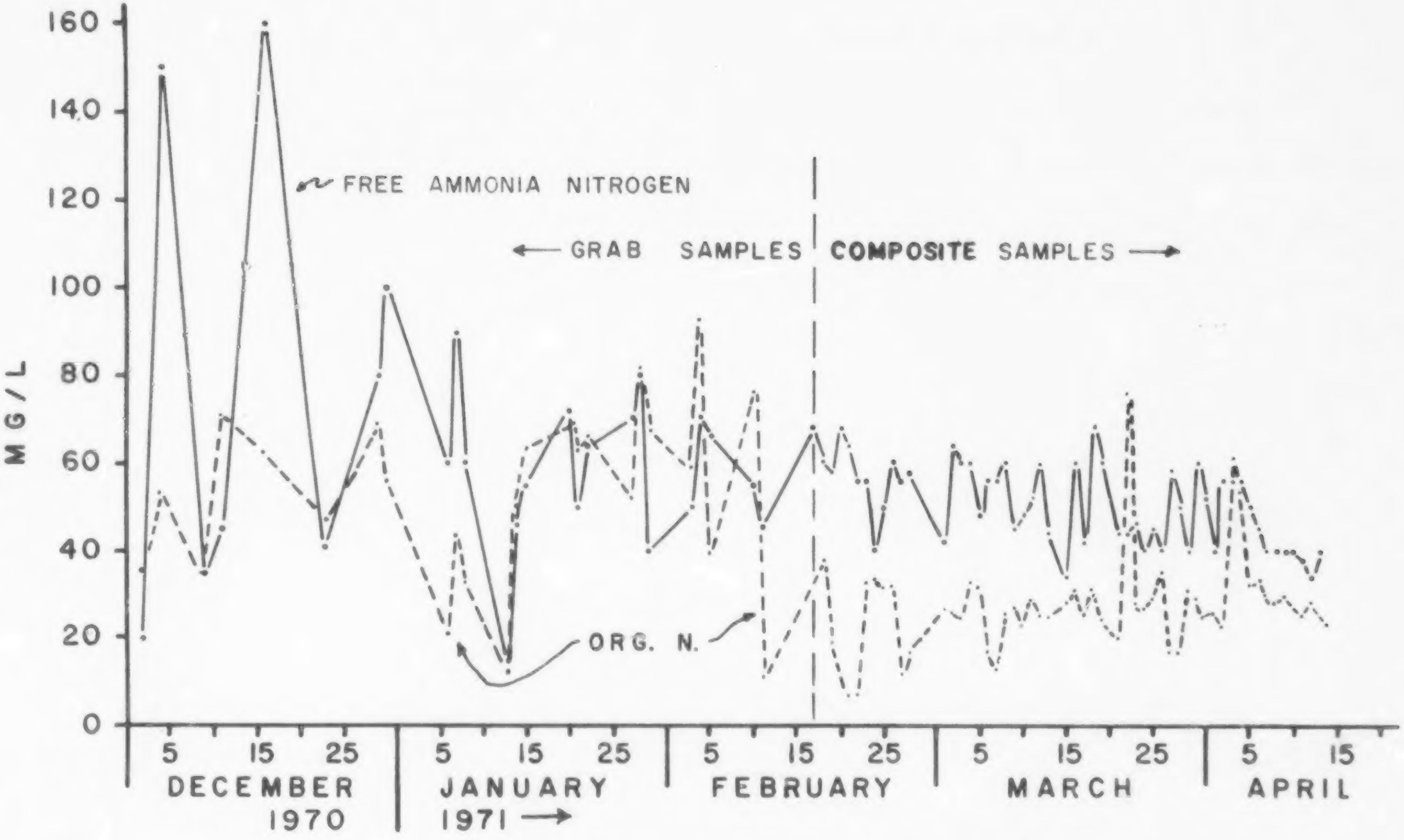


FIGURE 69 NITROGEN

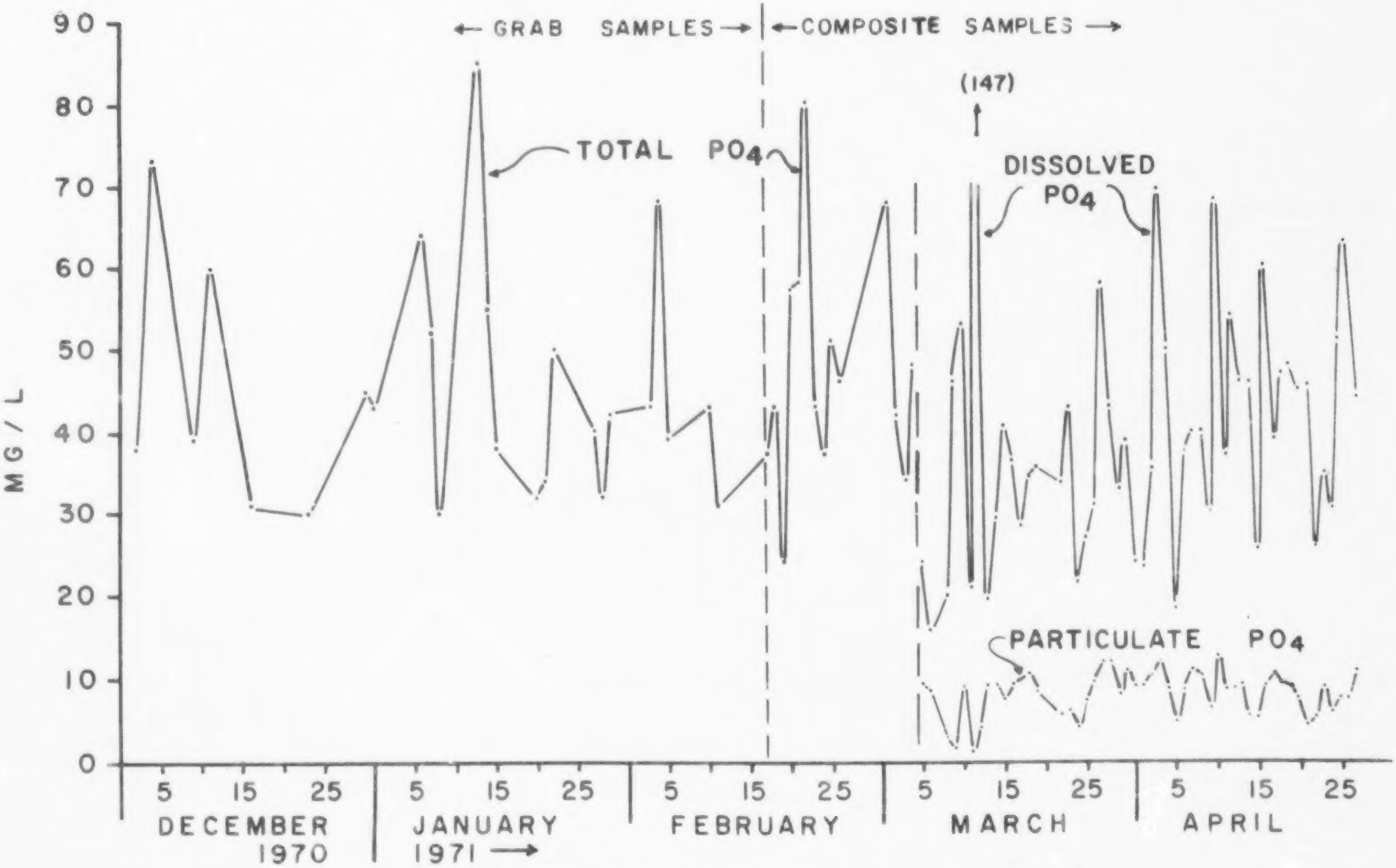


FIGURE 70 PHOSPHATE

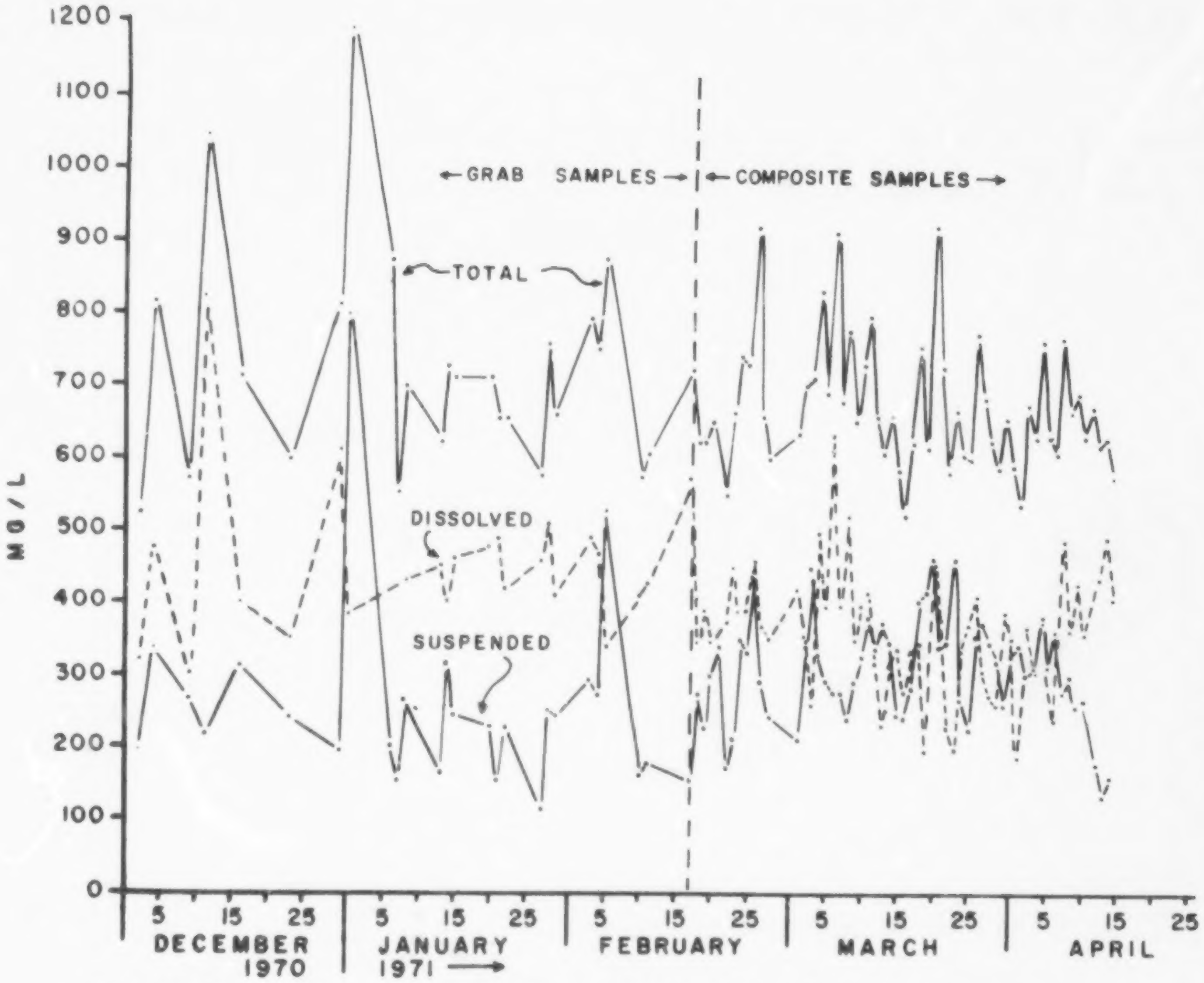


FIGURE 71 TOTAL, DISSOLVED and SUSPENDED SOLIDS

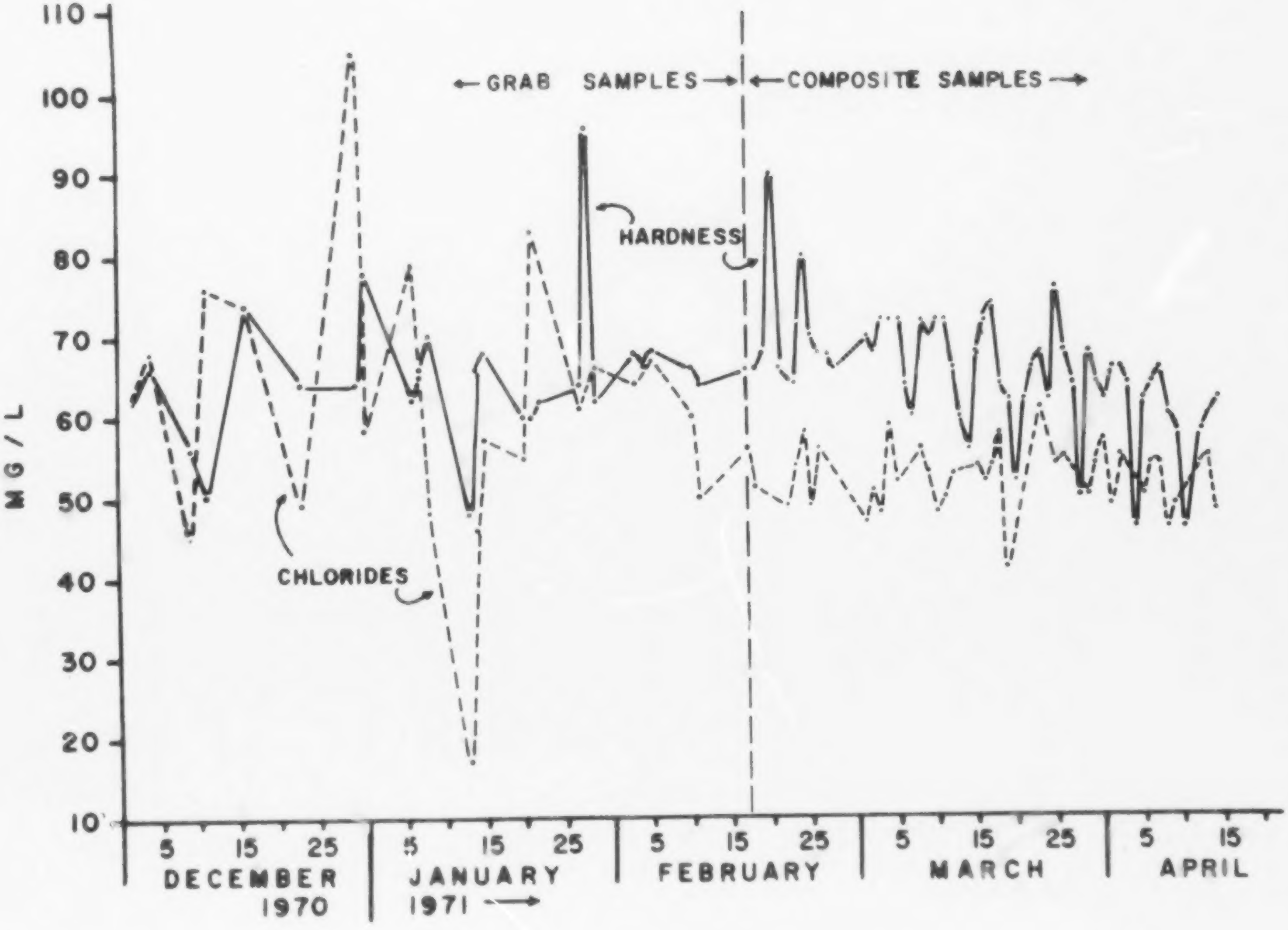


FIGURE 72 HARDNESS as $CaCO_3$ and CHLORIDES

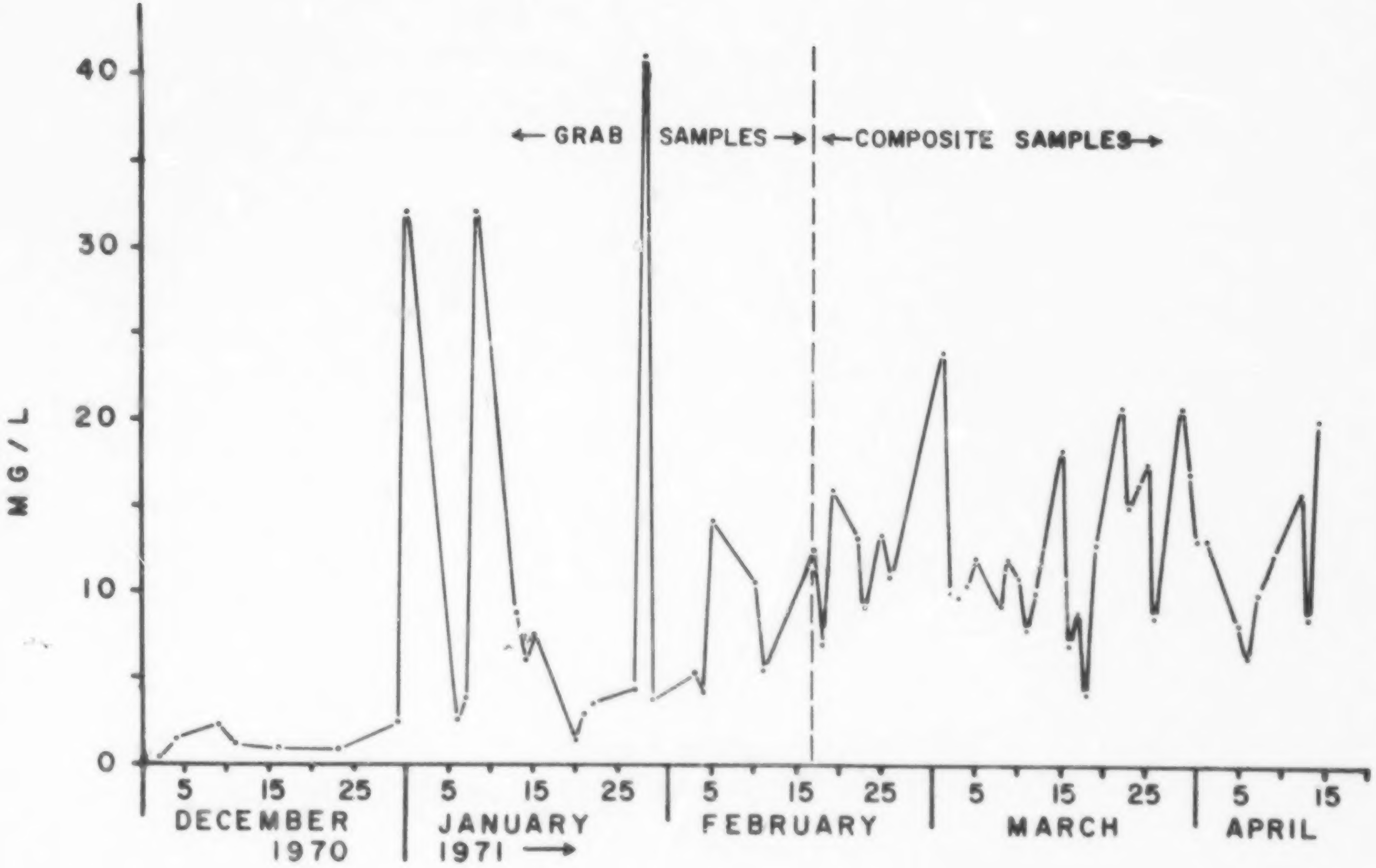
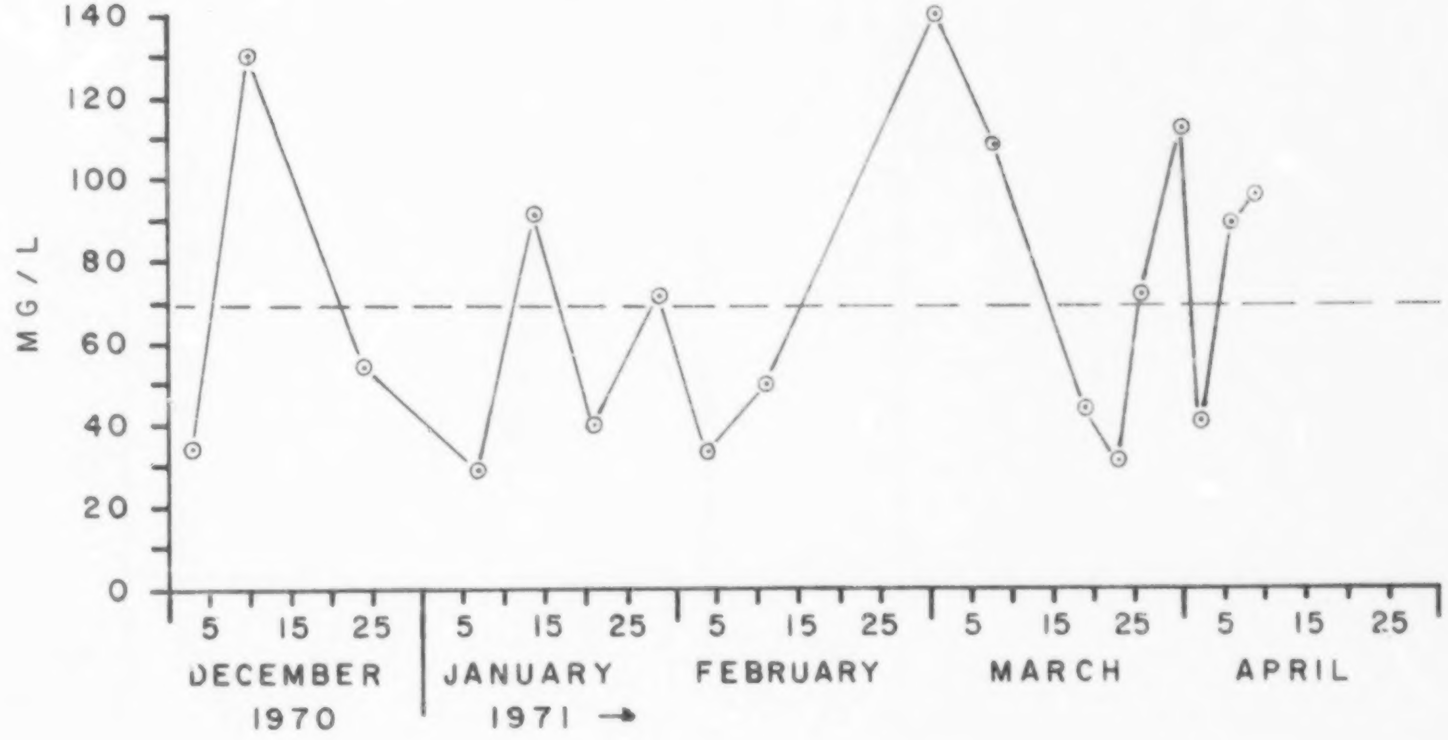


FIGURE 73 DETERGENT MBAS as LAS

FIGURE 74

PRESSURE SEWER SYSTEM DEMONSTRATION PROJECT - CHEMICAL ANALYSIS DATA

GREASE



The results of a long-range BOD test, which was run to better assess the character and treatability of the waste, are given in Figure 75.

Because of an interest in odors due to the anaerobic storage of wastewater in the pressure system, daily grab samples were taken and analyzed for sulfides. Special samples for sulfides were also taken over a twenty-four hour period. The results of these analyses are given in Figure 76.

Settleability Study -

In order to determine the possible effects of the GP unit on potential treatment of the waste by settling, several settleability studies were run on both the waste from the pressure sewer system and on a wastewater sample collected from a residential area in Albany sewered by conventional gravity sewers. A detailed description of the waste characteristics in the area sewered by conventional gravity sewers and the actual settleability test carried out is available elsewhere(32,33).

The results of the tests are summarized in Tables 29, 30 and 31 and presented graphically in Figures 77, 78 and 79.

Discussion

Table 32 shows a comparison of the data collected from the pressure system with values normally found in conventional sewage both on a concentration and a lbs/capita/day basis.

This data indicates that the pressure sewer waste is approximately 100% stronger than conventional waste when compared on a concentration basis. The higher strength is directly attributable to the complete elimination of infiltration in the pressure system (see Section VII).

On a gm/capita/day basis the pressure sewer waste contains approximately 50% less contaminents than reported for conventional domestic sewage. There are several possible reasons for this, such as, the percentage of children (75%) in the demonstration project site was considerably higher than the percentage found statewide (34%), and also, most of the children were of school age and thus were not in the homes for most of the day. The demonstration site contained no commercial development (offices, schools, etc.) which would add to the per capita values. Because of this, extrapolation of the per capita values to a more typical area should be done with caution.

The classical shape of the long-range BOD test indicates that except for the difference in strength the wastewater is similar to conventional wastewater.

Since differences in concentration and per capita flows are significant, they must be taken into account in the design of wastewater treatment facilities which would serve such a system.

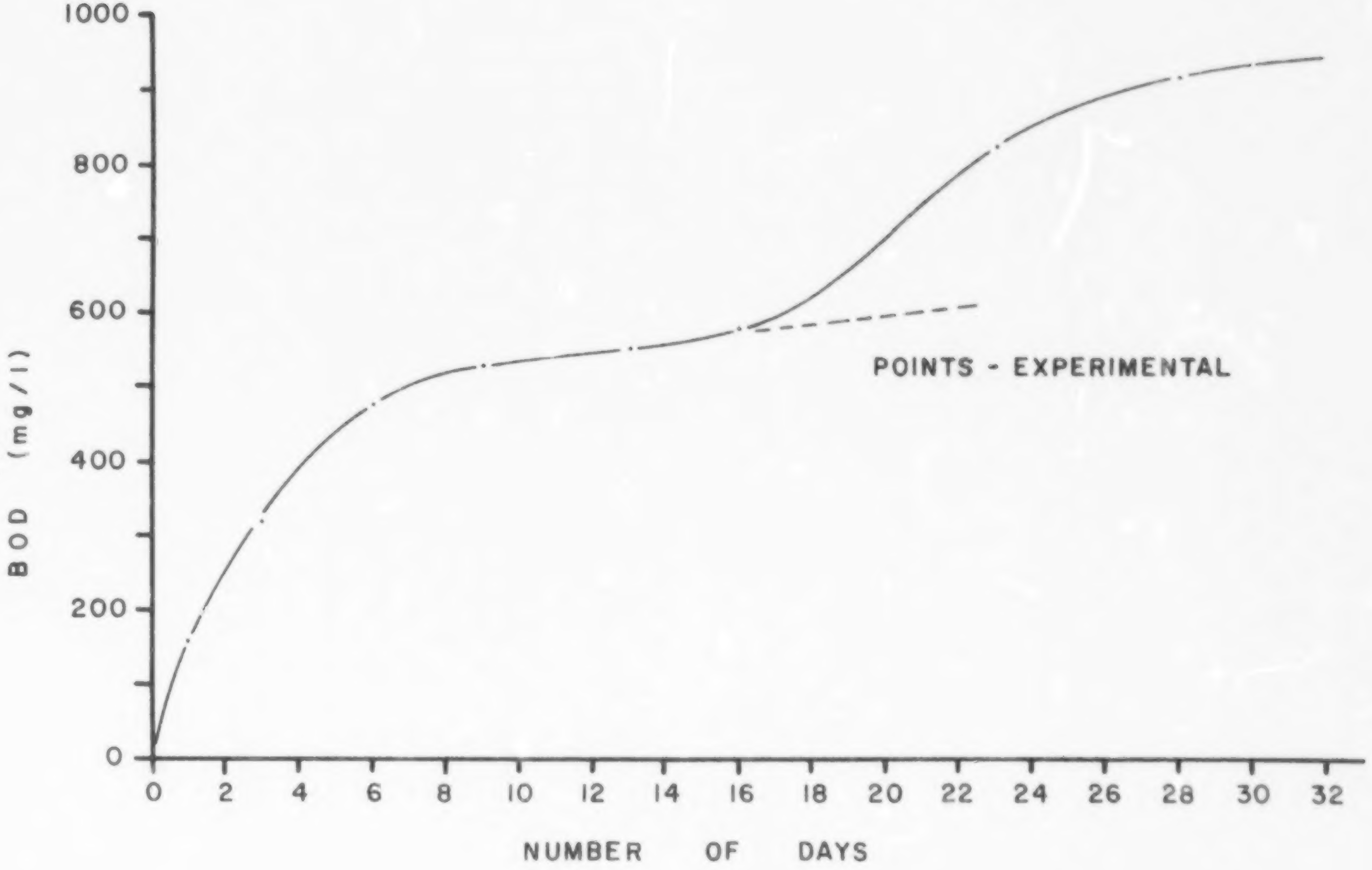


FIGURE 75 LONG RANGE BOD RESULTS

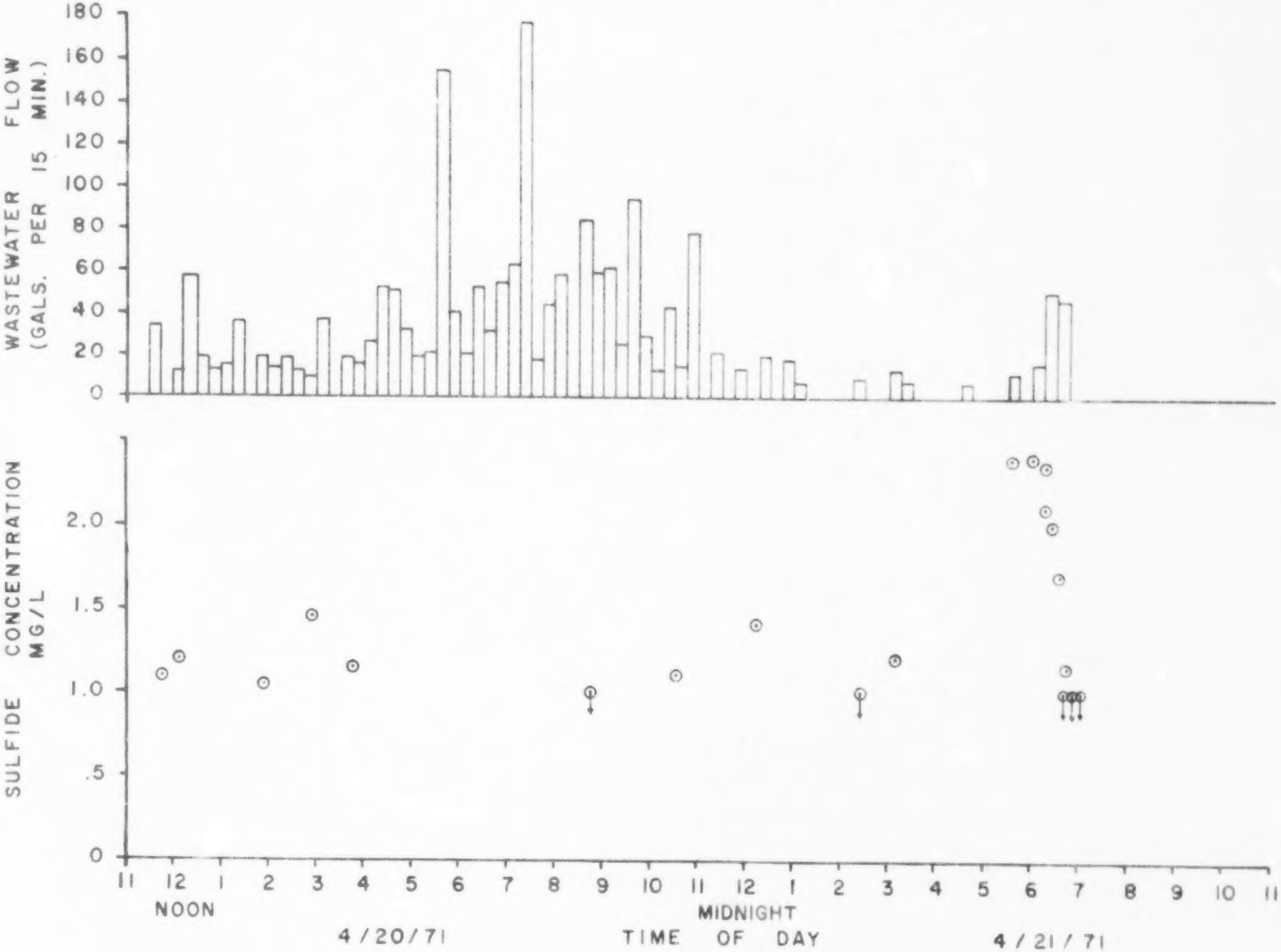


FIGURE 76 SULFIDES

TABLE 29

SUMMARY OF SETTLEABILITY TEST - GRAVITY SEWER SYSTEM WASTE

	Average Suspended Solids Concentrations (mg/l)						
Depth (ft) \ Time (min)	0	10	20	30	40	60	90
1		118	98	92	86	83	79
3		135	109	111	92	84	82
5		139	118	114	98	86	85
7		156	129	123	108	88	86
Avg.	143 at time = 0						
	Average Percentage Removal						
1		17	31	36	40	42	45
3		5	24	21	36	41	43
5		3	17	20	31	40	41
7		0	10	14	24	38	40

TABLE 30

SUMMARY OF SETTLEABILITY TEST - PRESSURE SEWER SYSTEM WASTE

Average Suspended Solids Concentrations (mg/l)

Depth (ft) \ Time (min)	0	10	20	40	60	90	120
1		240	205	182	150	132	109
3		>277	236	210	163	155	128
5		>277	243	215	164	160	135
7		>277	255	219	171	163	139
Avg.	277 at time = 0						

Average Percentage Removal

1		13	26	34	46	52	61
3		0	15	24	41	44	54
5		0	12	22	40	42	51
7		0	8	21	38	41	50

TABLE 31

COMPARISON OF SETTLEABILITY TEST RESULTS

Pressure Sewer System Waste		Gravity Sewer System Waste	
Overflow Rate (gpd/ft^2)	Removal Percentage(%)	Overflow Rate (gpd/ft^2)	Removal Percentage(%)
1188	45	1512	43
1458	37	2160	34
1944	28	2700	27
2700	21		

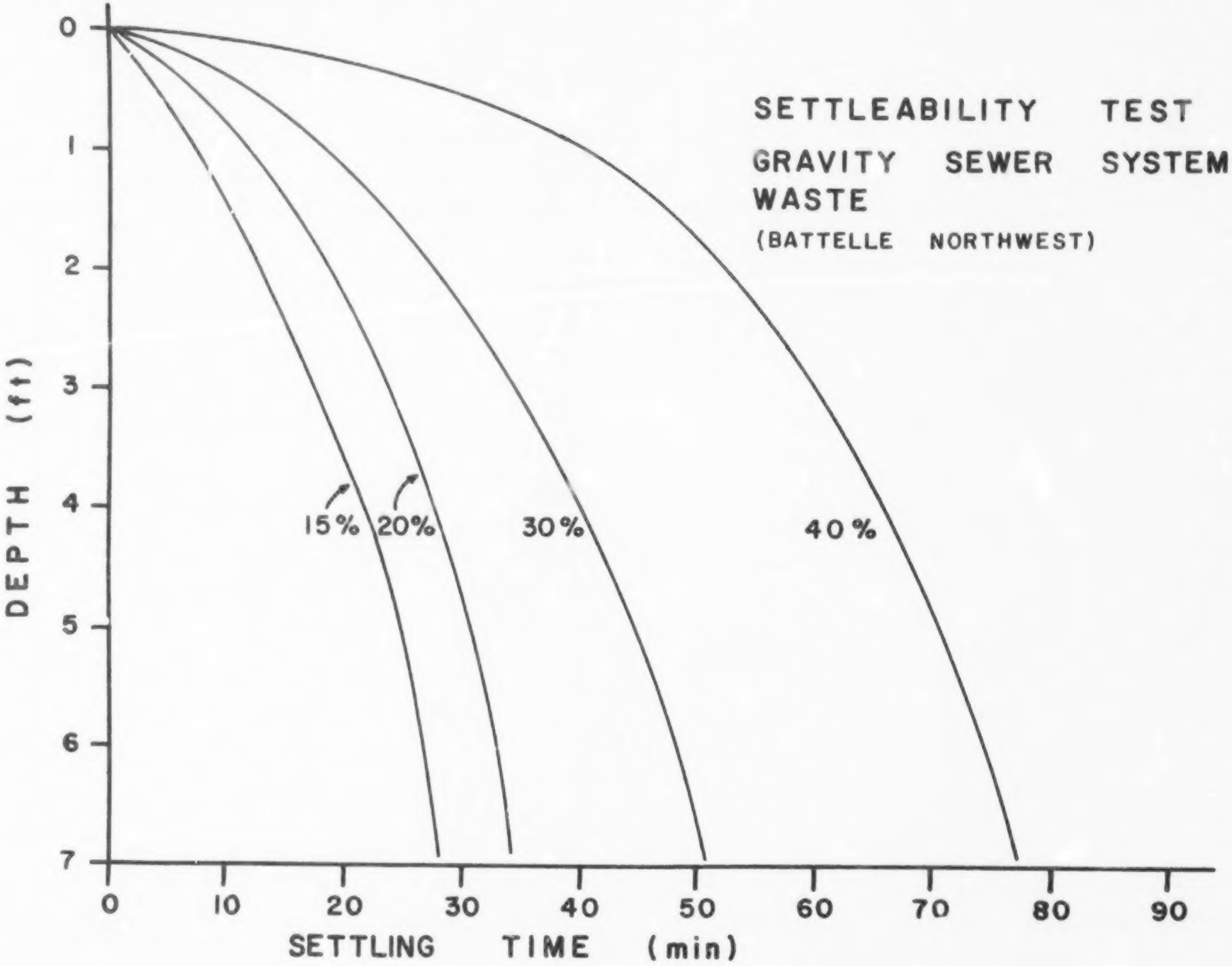

SETTLEABILITY TEST
GRAVITY SEWER SYSTEM
WASTE
(BATTELLE NORTHWEST)
DEPTH (ft)
0
1
2
3
4
5
6
7
15%
20%
30%
40%
0
10
20
30
40
50
60
70
80
90
SETTLING TIME (min)

FIGURE 77

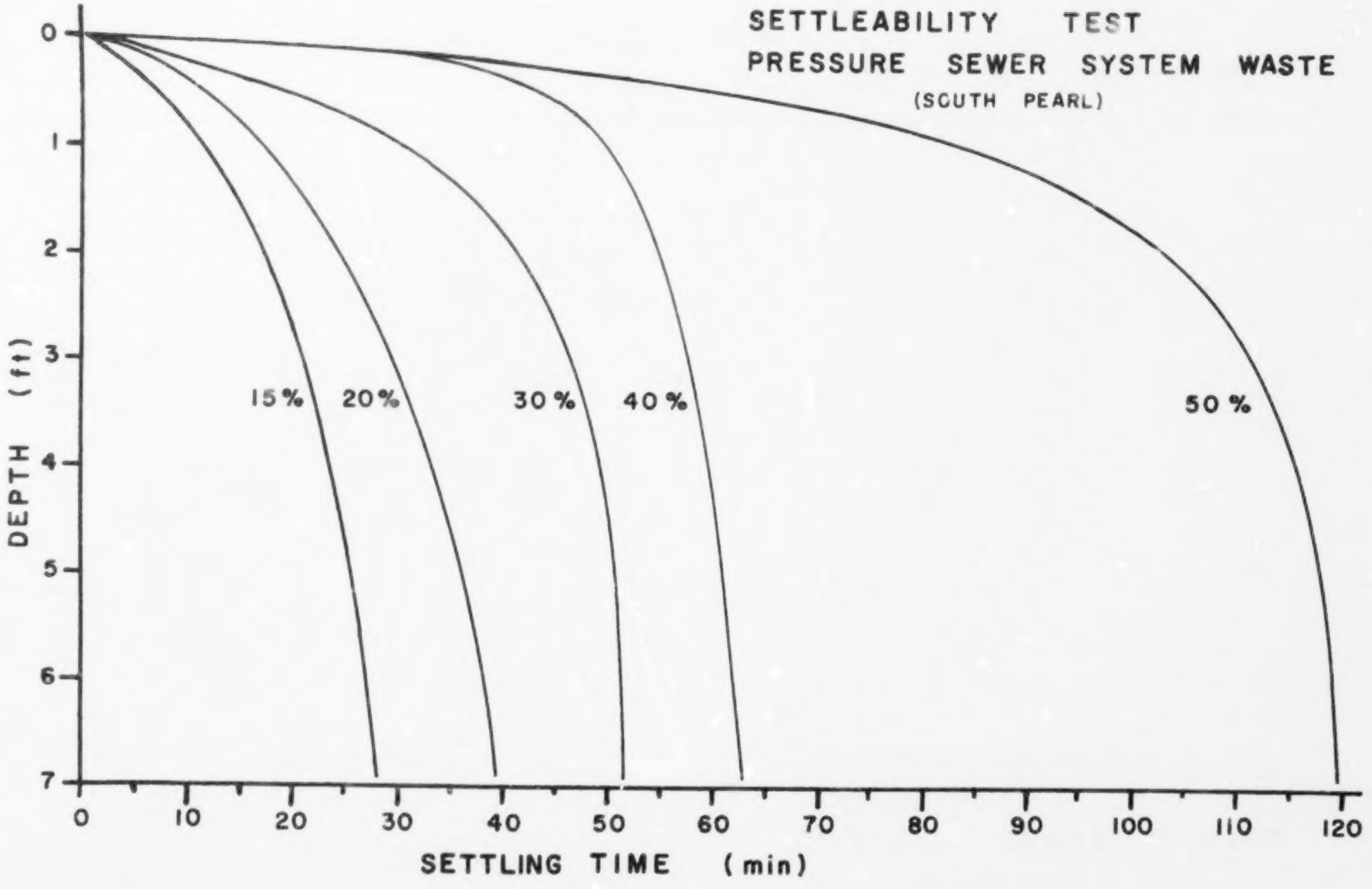

SETTLEABILITY TEST
PRESSURE SEWER SYSTEM WASTE
(SOUTH PEARL)
DEPTH (ft)
0
1
2
3
4
5
6
7
15%
20%
30%
40%
50%
0
10
20
30
40
50
60
70
80
90
100
110
120
SETTLING TIME (min)

FIGURE 78

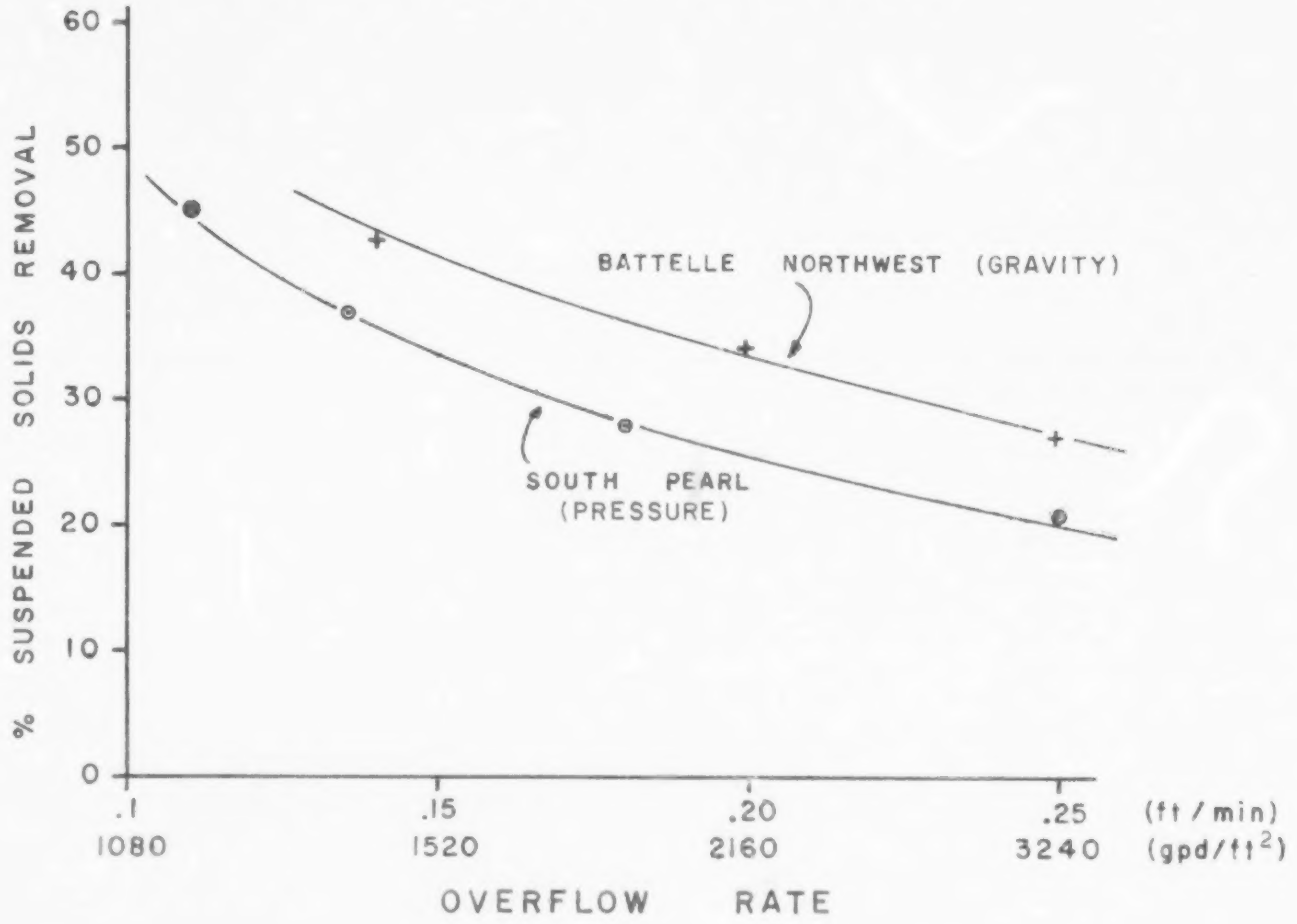


FIGURE 79 % SUSPENDED SOLIDS REMOVAL VERSUS OVERFLOW RATE

TABLE 32

COMPARISON OF PRESSURE SEWER SYSTEM WASTE WITH CONVENTIONAL WASTE

Parameter	Conventional Gravity System[1] Concentration mg/l	Conventional Gravity System[1] Loading gm/cap/day	Individual Home Systems[2] Concentration mg/l	Individual Home Systems[2] Loading gm/cap/day	Pressure Sewer System Concentration mg/l	Pressure Sewer System Loading gm/cap/day
5 Day Biochemical Oxygen Demand	180	68	284-542	44-158	330	39
Chemical Oxygen Demand	400	150	540-882	82-205	855	102
Total Solids	700	265	788-1249	113-216	681	81
Total Volatile Solids	350	132	414-659	60-138	476	56
Total Suspended Solids	200	76	293-473	44-106	310	37
Total Dissolved Solids	500	189	-	-	372	44
Settleable Matter[3]	70	-	-	-	15	--
Organic Nitrogen	20	7.5	-	-	29	3.5
Ammonia Nitrogen	11	4.2	48-92	8-16	51	5.9
Total Nitrogen	31	12	61-121	11-20	80	9.4
Total Phosphorus	11	4	15-21	1.9-5.7	16	1.93
Chloride	23	8	-	-	52	6.1
Grease	40	15	33-95	6.1-28	81	10.35
Flow	-	100 gal/cap/day	-	24-78 gal/cap/day		32 gal/cap/day

---

1. These values were selected as typical after an examination of various references.(34,35,36,37,38,39,40,41,42)

2. As reported by Watson et al.(43)

3. Expressed as mg/l.

As can be seen in Figure 76, little sulfide production was found although sulfide odors were observed in and around the discharge end of the system. From the data and the observations, it is concluded that, although no major problem from sulfide production should be anticipated, some method of freshening the wastewater as it enters a treatment system will be desirable to avoid odor problems at the treatment plant. If the system is to be discharged to a gravity sewer, some provisions for odor control also appear desirable.

The results of the settleability test (Figures 77 and 78) are most clearly shown by examination of Figure 79. Overflow rates used in settling tank design normally range between 1000-2000 gal/day/ft^2. If one examines Figure 79 at a typical design overflow rate of 1500 gal/day/ft^2, it can be seen that the expected percent removals would be 41 and 35 for the wastewater from the gravity and pressure sewer system respectively. These values are typical of reported ranges for domestic sewage and are for practical purposes equivalent. Thus the macerating operation of the GP units had little effect on the settling characteristics of the waste and it can be concluded that overflow rates traditionally used in the design of settling tanks for domestic wastewater will be adequate in the design of systems to treat wastewater from a pressure sewer system.

Conclusions

1. The concentration of various pollutants in a pressure sewer system was found to be approximately 100% greater than those found in conventional systems.

2. On a gm/capita/day basis the pressure sewer waste contained approximately 50% less contaminates than reported for conventional domestic sewage.

3. Settleability tests showed no significant differences in the settleability of the waste from the pressure sewer system when compared to conventional systems.

4. The difference in the strength of the waste must be taken into account in designing treatment facilities for a pressure system.

5. No major problems from sulfide production in a pressure system should be anticipated but some method of freshening the wastewater as it enters a treatment system or a gravity sewer may be desirable to avoid odor problems.

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Section IX

ACKNOWLEDGEMENTS

Project Staff

Leo J. Hetling - Project Director
Italo G. Carcich- Project Engineer
Patrick Hanley - Project Technician
Stanley House - Project Technician

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Rev. Warren Brown

Michael Nardolillo

Final Report Typing

Mrs. Kathryn Relyea

Mrs. Helen Rest

Mrs. Jean Janaitis

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APPENDIX A

HOUSEHOLD SURVEY INFORMATION SHEET

1. Household #

   Name______________________________

2. Occupancy of House

   Adults ________

   Children ________

   Total ________

3. Appliances

Appliances	Yes	No
Wringer Washing Machine	______	______
Automatic Washing Machine	______	______
Dishwasher	______	______

4. Number of Bedrooms ________

5. Number of Baths ________

APPENDIX B

```
DAILY          Daily Report Written

   1*
   2*setting of tab for use in programlisting and input
13000 FUNCTION REG(I)
13010 COMMON IP,IL,I5
13020  IF(I5<100)I5=I5+1000
13030  REG=INT(977.*FLOAT(I)/FLOAT(I5))
13040 RETURN;END
20000 SUBROUTINE TIME(I,J,N,N2)
20100 DIMENSION I(N),J(N2)
20110  DO 1 K=1,N
20120  IS=I(K)*I5;J(2*K-1)=IS/60;J(2*K)=MOD(IS,60)+100
20130 1 CONTINUE
20140 RETURN;END
22000 SUBROUTINE UNDERLNE(N)
   22010*Subroutine to underline N spaces
22020 LOGICAL L
22030 ALPHA UNDER,BACKSPACE,NULL
22040 100 FORMAT(1H&,A4)
22050 101 FORMAT(1H&,A1)
22060 102 FORMAT(1H&,A2)
22070 103 FORMAT(1H&,A3)
22075 104 FORMAT(1H+)
22080 NB=N/4;NR=MOD(N,4)
22090 IF (L)GOTO 1
22100 SET("CONCO*E")TO 95;READ("CONCO*E")UNDER
22130 L=.TRUE.;CLOSEFILE "CONCO*E"
22140 1 PRINT 104
22230 6 IF(NB.EQ.0)GOTO 10
22240  DO 9 I=1,NB
22250 9 PRINT 100,UNDER
22260 10 IF(NR.EQ.0)GOTO 14
22270 GOTO(11,12,13),NR
22280 11 PRINT 101,UNDER;GOTO 14
```

Reproduced from best available copy.

```
22290 12 PRINT 102,UNDER$GOTO 14
22300 13 PRINT 103,UNDER
22310 14 RETURN$END
50010 COMMON IP,IL,I6
50100 DIMENSION IMP(12),I34(2),MOP(96,12),MOPT(32)
50105 DIMENSION NSP(48)
50110 FILENAME FI,FDUM
50120 LOGICAL L,LR
50130 DIMENSION NOV(12),NDO(12),PABX(12),PAVX(12),PAVN(12)
50140 DIMENSION K2(12),K3(12),K4(12),K5(12),K6(12),K7(12)
50150 DIMENSION FR15(12),FR60(12),FIOT(12),FDT(12),FNT(12)
50160 ALPHA ADUM
50170 DIMENSION MXPH(12),MAVPH(12),MNAVPH(12)
50171 DIMENSION MXNOP(12),MNIMPS(1),PXNOP(12)
50172 DIMENSION NS(45),MPRTS(2)
50175 DIMENSION IMINP(1)
50180 DIMENSION CALAX(12),CALBX(12),CALAM(12),CALBM(12)
50190 DIMENSION K40(12),FL(12),K50(12),K501(12),K502(12)
50200 DIMENSION NOT(12),IPD(12),AVOP(12)
50210 DIMENSION K401(12),K402(12),K60(12)
50220 INTEGER DATE(3),DAYMO(12)
50230 DIMENSION MNIMP(12),MNIMF(12),MPRT(24)
50240 DIMENSION MFL(96,12),MFLT(32)
50300 DATA IMP/1,2,3,4,5,6,7,8,9,10,11,12/
50305 DATA N1,N2,N12,N24/1,2,12,24/
50310 DATA I34,I58/3,37,58/IS1,IS7/2,7/
50320 DATA CALAX/121.3,105.6,104.5,118.4,107.7,96.4,114.7,110.8,109.8,104.3,108.9,104.7/
50330 DATA CALBX/.1239,.111,.1096,.1226,.1109,.1058,.1195,.1153,.116,.1133,.1148,.1048/
50340 DATA CALAM/107.6,107.5,111.2,116.5,156.1,108.1,110.6,110.1,112.3,107.5,113.2,107.3/
50350 DATA CALBM/.1156,.1153,.1163,.1248,.1737,.1107,.1161,.1152,.1196,.1153,.1194,.1102/
50360 DATA MAVPH/990,949,950,955,967,931,958,957,945,919,945,960/
50370 DATA MXPH,MXNOP/24*1000/
50380 DATA MNAVPH/931,996,934,926,885,972,947,954,933,929,940,969/
50420 DATA DAYMO/30,28,31,30,31,30,31,31,30,31,30,31/
50430 DATA MXMH/1000/L/.TRUE./
50490  LOAD
50500 100 FORMAT(58H DAILY REPORT OF OPERATIONS - PRESSURE SEWER
50501       & DEMONSTRATION,4XI2,2(1H/,I2),2X5HRUN #,XI3)
50510 101 FORMAT(14H0House Number ,12I6,2X5HSyst.)
50520 102 FORMAT(24H0Daily Maximum Pressure           ,12F6.1)
50530 103 FORMAT(26H Average Maximum Pressure         ,12F6.1)
50540 104 FORMAT(26H Average Minimum Pressure         ,12F6.1)
50550 105 FORMAT(24H0Peak 15 Min. Flow Rate           ,12F6.1)
50560 106 FORMAT(21H Peak 1 Hr Flow Rate              ,12F6.1)
50570 107 FORMAT(12H Total Flow   ,12F6.1)
50580 108 FORMAT(21H0Number of Overflows              ,12I6)
50590 109 FORMAT(14H Daytime Flow ,12F6.1)
50600 110 FORMAT(16H Nighttime Flow                   ,12F6.1)
50610 111 FORMAT(25H Power Outage Intervals           ,12I6)
50620 112 FORMAT(28H Number of Daily Operations       ,12I6)
50630 113 FORMAT(22H Total Operating Time             ,12F6.1)
50640 114 FORMAT(8H-MANHOLE)
50650 115 FORMAT(21H0Maximum Temperature              ,12I6)
50660 116 FORMAT(21H Minimum Temperature              ,12I6)
50670 117 FORMAT(21H Average Temperature              ,12I6)
50680 118 FORMAT(3(I2,X))
50690 119 FORMAT(24H Average Pump Rate(GPM)           ,12F6.1)
```

```
50700 120 FORMAT (1H&,F7.1)
50710 121 Format(26H0Number of Active Periods          ,I6)
50720 122 Format(26H0Time of Max. Pres.                ,I2(XI2,1H:,I2))
50730 123 Format(19H Time of Max. Flow                 ,I2(XI2,1H:,I2),2XI2,1H:,I2)
50740 124 FORMAT(23H Max. Non-op. Pressure             ,12F6.1)
50750 125 FORMAT(1H&,2XI2,1H:,I2)
50760 126 FORMAT(20H You are Limited to ,I3,24H runs by the "FLOW" File.)
50800 150 FORMAT(I5,5I3,I1)
50900 200 FORMAT(X12I4)
50910 201 FORMAT(X12F4.1)
51000 CALL SETTAB(IS1,I34,L)
51010 PRINT, "What is Run Number"
51020 INPUT,NR
51022  IL=1
51023  READ("FLOW")FDUM,FDUM,LNFL,IRFL
51024  LV=(LNFL-12*IRFL-2)/12!PRINT 126,LV
51025  READ("OPTIME")FDUM,FDUM,LNOP,IROP
51026  LV=(LNOP-12*IROP-2)/12!PRINT,"You are limited to ",LV," runs by the 'OPTIME' file."
51027  PRINT,"Type 1 if you wish to stop,else type F."
51028  INPUT,LR!IF(LR)STOP
51029  BACKSPACE "FLOW"!IF(IRFL>26)GOTO 70
51030  READ("FLOW")FDUM,FDUM,LNFL,IRFL,(NS(I),I=1,IRFL)
51031  GOTO 71
51032 70 READ("FLOW")FDUM,FDUM,LNFL,IRFL,(NS(I),I=1,26)
51033  READ("FLOW")(NS(I),I=27,IRFL)
51034 71 BACKSPACE "OPTIME"!IF(IROP>26)GOTO 72
51035  READ("OPTIME")FDUM,FDUM,LNOP,IROP,(NSP(I),I=1,IROP)
51036  GOTO 73
51037 72 READ("OPTIME")FDUM,FDUM,LNOP,IROP,(NSP(I),I=1,26)
51038  READ("OPTIME")(NSP(I),I=27,IROP)
51039 73 PRINT,"What is the Date of The Run"
51040  INPUT 118,DATE
51050 PRINT,"What File is the data stored in"
51060 INPUT,F1
52000  PRINT,"After ? Turn to top of page,Type something and return"
52010  INPUT,ADUM
52090  IF(IRFL.EQ.0)IRFL=1
52100  DO 65 I=1,IRFL
52110  IF(NR.LE.NS(I))GOTO 67
52120 65 CONTINUE
52130  GOTO 68
52140 67 IRFL=I
52150 68 IF(IROP.EQ.0)IROP=1!DO 69 I=1,IROP
52160  IF(NR.LE.NSP(I))GOTO 78
52170 69 CONTINUE
52180  GOTO 79
52190 78 IROP=I
52900 79 INIR=0!DATE(2)=DATE(2)+100
52910 DO 66 I=1,12
52920  K2(I)=MAVPH(I)!K3(I)=MNAVPH(I)
52930  K4I=K4(I)!K40(I)=K4I!K401(I)=K4T!K402(I)=K4T!K50(I)=K5(I)!K60(I)=K6(I)
52950 66 CONTINUE
53000 1 READ(F1,END=99)I2,I4,I7
53002  I1=I2/1000!I2=MOD(I2,1000)!I3=I4/1000
53004  I4=MOD(I4,1000)!I5=I7/10000!I6=MOD(I7/10,1000)!I7=MOD(I7,10)
53010  IRC=I1/2000
53020  IMC-MOD(I1/20,100)!IHSC=MOD(I1,20)
```

```
53030  ASSIGN 2 TO REDO
53040  IF(IMC-NR)1,2,3
53050 2 IF(IMC-IMIN)4,5,6
53060 4 PRINT,"Timing out of Order,"
53070  GOTO 97
53080 5 IF(IMSC>12)GOTO 7
53090  IF(IMSC.EQ.12)GOTO 8
53100  K=IMSC+1$K2(K)=I2$K3(K)=I3$K4(K)=I4$K5(K)=I5$K6(K)=I6$K7(K)=I7
53120  GOTO 1
53310 7  PRINT,"Channel Count Off"
53320  GOTO 97
54000 8 IF(I6>100.AND.I6<800)GOTO 36
54002  NAP=NAP+1
54005  IF(I6.EQ.977)GOTO 9
   54007*Adjust for Digital Supply Voltag
54008  I2=KEG(I2)$I3=KEG(I3)
54010  DO 10 I=1,12
54020  K2(I)=KEG(K2(I))$K3(I)=KEG(K3(I))$K4(I)=KEG(K4(I))
54030  K5(I)=KEG(K5(I))$K6(I)=KEG(K6(I))
54034 10 CONTINUE
54036 9 IF(LR)GOTO 11
   54037*Initialize Old Parameters
54040 DO 12 I=1,12
54042  K40(I)=K4(I)$K50(I)=K5(I)$K60(I)=K6(I)
54043  K401(I)=K4(I)$K402(I)=K4(I)
54044 12 LR=.TRUE.
54050 11 DO 20 I=1,12
   54059*Check for highest pressure
54060  K2I=K2(I)$IF(MXPH(I).LE.K2I)GOTO 16
54070  MNIMP(I)=IMC$MXPH(I)=K2I
   54079*Sum for average Maximum Pressure
54080 16 MAVPH(I)=MAVPH(I)+K2I
   54089*Sum for average Minimum Pressure
54090  MNAVPH(I)=MNAVPH(I)+K3(I)
54100  IF(K40(I)+12>K4(I))GOTO 17
54102  K40(I)=K40(I)+1000$K401(I)=K401(I)+1000$K402(I)=K402(I)+1000
54104 17 F460=FLOAT(K402(I)-K4(I))*.1
54106 IF(FR60(I)<F460)FR60(I)=F460
54108  NT=K40(I)-K4(I)
54110  FL(I)=FLOAT(NT)*.1
54112  NFL(IMIN+1,I)=NT
54115  FLI=FL(I)$FLT=FLT+FLI$FT460=FT460+F460
54120  IF(FR15(I).GE.FLI)GOTO 18
54125  FR15(I)=FLI$MNIMF(I)=IMC
54130 18 FTOT(I)=FTOT(I)+FLI
54140  K40(I)=K4(I)
54150  IF(K5(I)<K50(I)-20)K50(I)=K50(I)-1000
54155  K5I=K5(I)-K50(I)
54156  NOP(IMIN+1,I)=K5I
54160  IF(IABS(K5I)>20)GOTO 61
54162  IF(MXNOP(I)>K2I)MXNOP(I)=K2I$GOTO 19
54164 61 NDO(I)=NDO(I)+1
54170 19 TOT(I)=TOT(I)+FLOAT(K5I)*.015
54180  K402(I)=K401(I)$K401(I)=K40(I)$K40(I)=K4(I)
54190  K6S=K6(I)$IF(K6S<K60(I)-12)K60(I)=K60(I)-1000
54200  K6T=K60(I)-K6S$IF(IABS(K6T)>20)NOV(I)=NOV(I)+1
54210  K60(I)=K6S
```

```
54220  K50(I)=K5(I)
54230  IF(IMC>23.AND.IMC<86)FDI(I)=FDI(I)+FL(I)
54240  IF(IMC<24.OR.IMC>85)FNI(I)=FNI(I)+FL(I)
54250  IPO(I)=IPO(I)-K7(I)+1
54400 20 CONTINUE
   54405*Reserved for Temporary Listing of DVM Readings
54410  IF(MXMH.LE.I2)GOTO 21
54412  MXMH=I2$MXIMPS(I)=IMC
54420 21 MAVMH=MAVMH+I2
54430  MNAVMH=MNAVMH+I3
54440  FLOT=FLOT+FLT
54445  IF(FRI60<FI460)FRI60=FI460$IF(FRI15<FLT)FRI15=FLT
54450 FLT=0$FI460=0
54500  IMIN=IMIN+1$IF(IMIN>95)GOTO 60$GOTO 1
54790 30 IMINP(I)=IMIN$CALL TIME(IMINP,MPRIS,NI,N2)
54800 PRINT,"Voltage Dropout at "$PRINT 125,MPRIS$ASSIGN 1 TO REDO
54810  IL=IL+1$GOTO 6
54850 3 ASSIGN 6 TO REDO$IF(IMIN<96)GOTO 60
54860  GOTO 6
54900 99 IE=1$ASSIGN 6 TO REDO
   54999*Fill for inactive period
55000 6 DO 30 I=1,12
55010  MAVPH(I)=MAVPH(I)+K2(I)
55020  MNAVPH(I)=MNAVPH(I)+K3(I)
55030  K402(I)=K401(I)$K401(I)=K40(I)$K40(I)=K4(I)
55035  IF(IMIN>95)GOTO 30
55040  MFL(IMIN+1,I)=0
55050  MOP(IMIN+1,I)=0
55200 30 CONTINUE
55210  IMIN=IMIN+1$IF(IMIN>96)GOTO 60
55215  MAVMH=MAVMH+I2
55220  GOTO REDO
55500 60 DO 65 I=1,12
55510  PABX(I)=CALAX(I)-CALBX(I)*FLOAT(MXPH(I))
55512  PXNOP(I)=CALAX(I)-CALBX(I)*FLOAT(MXNOP(I))
55515  IF(PABXT<PABX(I))PABXT=PABX(I)
55520  PAVX(I)=CALAX(I)-CALBX(I)*FLOAT(MAVPH(I))/96.
55530  PAVN(I)=CALAN(I)-CALBN(I)*FLOAT(MNAVPH(I))/96.
55540  IF(PABX(I)<.7)PABX(I)=0$IF(PAVX(I)<.7)PAVX(I)=0$IF(PAVN(I)<.70)PAVN(I)=0
55550  IF(FTOT(I)<.7)FTOT(I)=0
55560  IF(FNI(I)<1.1)FNI(I)=0$IF(FDI(I)<1.1)FDI(I)=0
55570  IF(FR15(I)<1.1)FR15(I)=0$IF(FR60(I)<1.1)FR60(I)=0
55580  IF(IOT(I)<.5)IOT(I)=0$IF(IOT(I).EQ.0)GOTO 65
55590  AVOP(I)=FTOT(I)/IOT(I)
55595  FDOT=FDOT+FDI(I)$FNOT=FNOT+FNI(I)
55600 65 CONTINUE
55610  PMMH=110.6-.1125*FLOAT(MXMH)
55620  PMMHA=110.6-.1125*FLOAT(MAVMH)/96.
55630  IF(PMMHA<0.7)PMMHA=0
55640  IF(NAP<6)GOTO 66
   56000*Print out of Data
56010  PRINT 100,DATE,NH$CALL UNDERLNE(158)$PRINT 101,IMP
56020  PRINT 102,PABX
56025  PRINT 120,PABXT
56027  PRINT 124,PXNOP
56030  PRINT 103,PAVX
56040 PRINT 104,PAVN
```

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DAILY(Continued)   Daily Report Written

```
56050 PRINT 105,FR15
56055  PRINT 120,FRI15
56060  PRINT 106,FR60
56065  PRINT 120,FRI60
56080  PRINT 109,FDT
56090  PRINT 120,FDGT
56100 PRINT 110,FNT
56101  PRINT 120,FNGT
56102  PRINT 107,FTGT
56103  PRINT 120,FLGT
56104 PRINT 108,NOV
56110  PRINT 111,IPO
56120 PRINT 112,NDO
56130 PRINT 113,TOT
56135  PRINT 119,AVOP
56140 PRINT 114!CALL UNDERLNE(157)
56150 PRINT 115,NIMAX
56170 PRINT 116,NIMIN
56180 PRINT 102,PMNM
56190  PRINT 103,PMMMA
56200  PRINT 121,MAP
56210  CALL TIME(MNIMP,MPHT,N12,N24)!PRINT 122,MPHT
56215  CALL TIME(MNIMPS,MPHTS,N1,N2)!PRINT 125,MPHTS
56220  CALL TIME(MNIMF,MPHT,N12,N24)!PRINT 123,MPHT
56500  SET("FLOW")TO IRFL*12-9!SET("OPTIME")TO IROP*12-9
56510  DO 64 I=1,12
56520  DO 62 J=1,32
56530  J2=3*J!J0=J2-2!J1=J2-1
56540 MFLT(J)=MFL(J2,I)+1000*(MFL(J1,I)+1000*MFL(J0,I))
56550  MOPT(J)=MOP(J2,I)+1000*(MOP(J1,I)+1000*MOP(J0,I))
56560 62 CONTINUE
56570  WRITE("FLOW")MFLT!WRITE("OPTIME")MOPT
56580 64 CONTINUE
56590  NS(IRFL)=NR!NSP(IROP)=NR
56600  SET("FLOW")TO 1!SET("OPTIME")TO 1
56610  IF(IRFL>26)GOTO 74
56620  WRITE("FLOW")DAT(X),CLK(X),LOF("FLOW"),IRFL,(NS(I),I=1,IRFL)
56630  GOTO 75
56640 74 WRITE("FLOW")DAT(X),CLK(X),LOF("FLOW"),IRFL,(NS(I),I=1,26)
56650  WRITE("FLOW")(NS(I),I=27,IRFL)
56660 75 IF(IROP>26)GOTO 76
56670  WRITE("OPTIME")DAT(X),CLK(X),LOF("OPTIME"),IROP,(NSP(I),I=1,IROP)
56680  GOTO 77
56690 76 WRITE("OPTIME")DAT(X),CLK(X),LOF("OPTIME"),IROP,(NSP(I),I=1,26)
56700  WRITE("OPTIME")(NSP(I),I=27,IROP)
56710 77 IRFL=IRFL+1!IROP=IROP+1
56800  IL=IL+34!CALL SLEW(IL)
56900 66 CONTINUE
59000  NR=NR+1!IL=1!IMIN=0!IF(IE.EQ.1)GOTO 98
   59005*Reset Cumulative Parameters for New Day
59010 DO 91 I=1,12
59020  MXPH(I)=1000!MAVPH(I)=990!MNAVPH(I)=990
59025  MXNOP(I)=1000
59030  FL(I)=0!NDO(I)=0!FNT(I)=0!FDT(I)=0!FTDT(I)=0!NOV(I)=0
59040  FR15(I)=0!FR60(I)=0!TOT(I)=0
59050  IPO(I)=0
59060  AVOP(I)=0
```

DAILY(Continued) Daily Report Written

```
59200 $1 CONTINUE
59205  NAP=0
59210  MXH=1000$MAVAH=12$DATE(2)=DATE(2)+1$FDGI=0$FNGT=0
59215  FLGI=0$PABXI=0$FRI15=0$FRI60=0
59220  IF(DATE(2)<DAYMO(DATE(1))+100)GOTO 1
59230 DATE(1)=DATE(1)+1$DATE(2)=101
59240  IF(DATE(1)<13)GOTO 1
59250  DATE(3)=DATE(3)+1$DATE(1)=1$GOTO 1
59900 $7
60000 $8 STOP$END
```

APPENDIX C

TYPICAL RESULTS OF THE MECHANICAL PERFORMANCE OF GP UNITS PRIOR TO INSTALLATION

DATA SHEET

PSG SER. NO. 8
DATE 2-9-70
SIGNED R. [illegible]

I. IA, IB, IC - COMMENTS

A+B O.K.

C - LEAK AT SCREW - SEALED WITH RTV

II.

PSI	TIME	VOL.	GPM	WATTS	AMPS	VOLTS
~~0~~						
~~5~~						
~~10~~ 9.5	—	—	14.2	930	6.2	232
15	—	—	13.5	960	6.4	232
20	—	—	13.0	1010	6.6	231
25	—	—	12.7	1050	6.8	230
30	—	—	11.8	1110	7.0	228
35	—	—	11.5	1170	7.2	228

III. COMMENTS

O.K. WITH STEEL TANK

IV. SET POINT FOR SHUT OFF ______

	TURN ON HT	TURN OFF HT
Run #1		
Run #2		
Run #3		
Run #4		
Run #5		

V. COMMENTS

VI. HIPOT TEST RESULTS ____________________

LEAKAGE TEST RESULTS 83 [illegible]

VII. COMMENTS

O.K

VIII. COMMENTS

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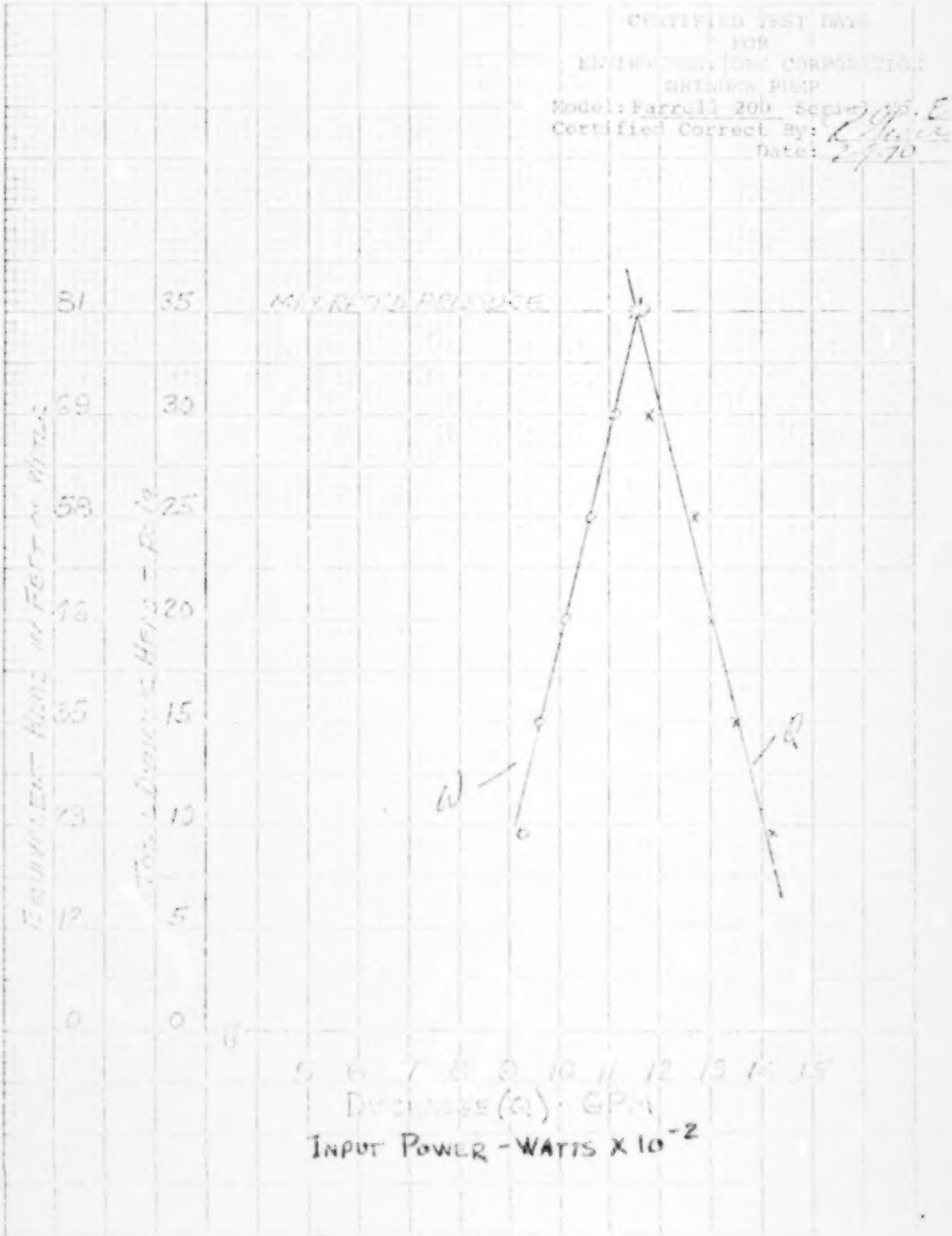

CERTIFIED TEST DATA
FOR
ENVIRONMENT/ONE CORPORATION
GRINDER PUMP
Model: Farrell 200 Serial 305.E
Certified Correct By: [illegible]
Date: 2-4-70

APPENDIX D

Malfunction Number	GP Unit	Reason for Malfunction	Cause of Malfunction	Date	Time Out	Date	Time In	Total Time Out(hrs.)
1-P	9	Unit's Motor Continuously Running	Faulty Pressure Switch and on-delay timer	11/2/70	20:25	11/3/70	11:00	14:35
2-P	9	Unit's Motor Continuously Running	Leak in pressure sensing tube - Was replaced	11/22	06:00	11/22	09:15	3:15
3-P	1	Unit's Motor Continuously Running	Pressure sensing tube functioning improperly	11/22	13:15	11/24	09:45	44:30
4-P	3	Unit too noisy	Motor's pulley rubbing against motor's guard	11/28	15:45	11/28	18:00	2:5
5-P	3	Unit too noisy and motor running continuously	Pressure Switch faulty and motor's pulley tightened	12/9	21:15	12/10	08:15	11:00
6-P	3	Unit's Motor Continuously Running	Replaced pressure sensing tube with 3" bell shape tube	12/15	00:00	12/18	14:00	86:00
7-P	9	Unit in Overflow Condition	Replaced pressure sensing tube with 3" bell shape tube	12/25	10:00	12/30	15:15	125:15
8-P	9	Unit's Motor Continuously Running	Made adjustments on pressure switch and pressure sensing tube	1/2/71	09:00	1/5/71	12:00	75:00
9-P	9	Unit's Motor Continuously Running	Replaced badly wormed pump starter due to previous lengthy operations (7,8)	1/10	22:00	1/12	08:30	34:30
10-P	3	Unit Too Noisy	Badly wormed bearing from motor to cutting wheel	1/21	14:15	1/22	16:00	25:45
11-P	10	Unit's Motor Continuously Running	Replaced pressure sensing tube with 3" bell shape tube	1/27	18:00	2/1	14:45	116:45

Malfunction Number	GP Unit	Reason for Malfunction	Cause of Malfunction	Date	Time Out	Date	Time In	Total Time Out (hrs.)
12-P	9	Unit in Overflow Condition	Power turned off in basement for no apparent reason	2/3/71	17:00	2/5/71	09:30	40:30
13-P	8	Unit's Motor Running Cycle Lengthier than Normal	Pressure Sensing Tube has high build-up - prevents normal operation	2/14	08:00	2/17	16:00	80:00
14-P	6	Unit in Overflow Condition	Pressure Sensing Tube Setting too high - Changed to 3" bell shape tube	2/14	21:15	2/16	14:45	41:30
15-P	4	Unit in Overflow Condition	Pressure Sensing tube clogged; would not turn unit on	2/15	15:15	2/16	16:15	25:00
16-P	5	Unit in Overflow Condition	Pressure Sensing tube clogged - Changed to 2" bell shape tube	2/15	19:30	2/16	12:45	17:15
17-P	7	Unit's Motor Running Continuously	Replaced pressure sensing tube with 3" bell shape tube	2/18	07:45	2/22	13:45	102:00
18-P	6	Unit's Motor Continuously Running	Replaced on-delay timer, relay and adjusted pressure sensing tube	2/18	17:15	2/19	09:00	15:45
19-P	4	Unit's Motor Continuously Running	Air in discharge line; pump lost prime	2/21	20:15	2/22	13:00	16:45
20-P	1	Unit's Motor Continuously Running	Flapper Assembly Faulty inside check valve; also replaced pressure sensing tube	2/21	20:00	2/24	15:15	67:15
21-P	8	Unit in Overflow Condition	Replaced on-delay timer and relay	2/21	20:00	2/22	15:00	19:00
22-P	12	Unit's Motor Continuously Running - Also unit a little noisy	Replaced a cracked pump stator - also pressure sensing tube - Straightened the pulley from hitting metal guard	2/27	22:30	3/2	09:30	59:00

Malfunction Number	GP Unit	Reason for Malfunction	Cause of Malfunction	Date	Time Out	Date	Time In	Total Time Out (hrs.)
23-P	2	Unit's Motor Continuously Running	Replaced pressure sensing tube with 3" bell snape tube	3/4/71	07:15	3/9/71	13:00	125:45
24-P	7	Unit in Overflow Condition	Faulty on-delay timer	3/5	15:15	3/11	17:15	146:00
25-P	3	Unit too Noisy	Pulley hitting motor safety guard	3/12	17:00	3/12	17:15	0:15
26-P	11	Unit's Motor Continously Running Also Unit Quite Noisy	Replaced pressure sensing tube with 3" bell shape tube Pulley hitting motor's safety guard	3/30	08:30	4/1	15:15	54:45
27-P	8	Unit in Overflow Condition	Found no reason for malfunction - Back to normal operation after inspection	4/4	11:00	4/5	15:45	28:45
*28-M	5	Unit's Motor Continuously Running	Air lock in discharge pipe Pump lost prime	4/7	06:00	4/7	15:15	9:15
*29-M	2	Unit's Motor Continuously Running	Unit running for over 24 hours. Thermal overload failed to stop motor - Replaced entire Model 210 core	4/10	12:30	4/14	13:15	96:45
*30-M	9	Unit Not functioning properly - Some cycles are much longer than normal	Faulty on-delay timer - replaced	8/9	15:30	8/9	15:45	:15
*31-M	9	Unit not functioning properly - Operating cycles lengthier than normal	Replaced normally used timer with new model with a shorter shut-off delay time of 28 sec.	8/10	09:00	8/10	11:00	2:00
32-P	11	Unit's motor continuously running; Also quite noisy	Unit ran continuously for some time - was turned off by home owner because of excessive noise	8/14	00:00	8/14	10:30	10:30
33-P	11	Unit quite noisy again	Coupling belt loose between grinding shaft and motor	8/14	13:00	8/16	13:45	48:45

Malfunction Number GP Unit	Reason for Malfunction	Cause of Malfunction	Date	Time Out	Date	Time In	Total Time Out (hrs.)
34-P 11	Unit in Overflow Condition	No apparent reason for this malfunction - Unit was placed back in operation after inspection	8/23/71	02:00	8/23/71	18:00	16:00
35-P 11	Unit's Motor Continuously Running	Replaced pump's stator and on-delay timer - Unit was shut off by motor's thermal overload switch	8/24	00:15	8/24	08:45	8:30
36-P 11	Unit in Overflow Condition	Air lock in discharge pipe - Pump lost its prime	8/24	18:00	8/25	15:30	21:30
37-P 11	Unit's Motor Continuously Running	Motor operated for 2 hrs. continuously; then went back to normal operation - no justification recorded for this occurrence	8/26	11:00	8/26	13:00	2:00
38-P 11	Unit's Motor Continuously Running	Replaced pressure switch - tightened bolts connecting pump to motor - placed back in operation	8/27	20:15	9/1	09:45	113:13
39-P 11	Unit in Overflow Condition	Power turned off because of noisy operation. Removed and replaced motor, pump and check valve flapper assembly	9/2	11:30	9/3	09:45	22:15
40-P 11	Unit Not Functioning properly - Pumping air	Unit started after inspection and no indication for the malfunction was discovered	9/3	18:15	9/5	15:00	44:45
41-P 11	Unit in Overflow Condition	No apparent reason for this malfunction	9/11	23:15	9/14	15:15	64:00
42-P 10	Unit in Overflow Condition	Power was turned off by owner at the main power terminal. No reason given.	9/11	12:00	9/14	16:15	76:15

Malfunction Number	GP Unit	Reason for Malfunction	Cause of Malfunction	Date	Time Out	Date	Time In	Total Time Out(hrs.)
43-P	11	Unit in Overflow Condition	Unit was permanently turned off - Otherwise a new core would have been required	9/19/71	15:30	11/8/71	11:30	1196:00
*44-M	8	Unit's Motor Continuously Running	Malfunction cannot be explained - However, home owner did some electrical work connecting wires to our control panel	10/14	07:30	10/14	16:00	8:30

P - Prototype GP Unit
M - Modified GP Unit

APPENDIX E

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              ************************************************
              NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
                  ENVIRONMENTAL RESEARCH AND DEVELOPMENT UNIT
              ************************************************

0          PROBLEM TITLE  *  PRESSURE SEWER WATER FLOW DATA
           DATE OF RUN    *  FEBRUARY 28, 1972
           ENGINEER       *  BOULTON,CARCICH
1                                     TOTAL DAILY FLOW PER CAPITA PER UNIT

0     DATE   RUN    UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   UNIT   TOTAL

             NO.      1      2      3      4      5      6      7      8      9     10     11     12   UNITS

      10/ 1    1    44.    53.8   42.2   19.6   53.4    0.0   23.5   64.7   41.9   54.4   35.2    0.0   34.4
      10/ 2    2    65.8   13.1   27.9   16.3   29.7    0.0   29.1   36.7   20.9   42.3   27.9    1.7   24.0
      10/ 3    3    41.8   18.5   31.0   12.8   27.9    0.0   32.3   27.5   26.2   90.3   29.0    0.5   24.4
  1   10/ 4    4    48.4   22.3   24.5   42.1   38.3    0.0   80.6   34.7   42.7   78.7   65.0    0.0   35.4
      10/ 5    5    86.2   19.5   41.0   25.9   61.5    0.0   37.9   44.2   74.4   44.3   42.2    0.0   38.5
      10/ 6    6    67.0   22.2   38.0   16.7   40.2    0.0   30.6   33.4   32.0   35.8   24.2    0.6   27.5
      10/ 7    7    54.3   66.4   35.1   14.7   28.9    0.0   41.1   49.8   28.3   72.4   24.9    0.0   32.4
      10/ 8    8    65.4   18.4   34.1   21.0   51.9    0.0   24.3   66.6   55.4   50.5   24.7    0.0   32.9
      10/ 9    9    60.0   62.2   34.0   20.0   25.5    0.0   16.7   46.4   32.1   73.7   18.1    0.0   30.7
      10/10   10    37.4   69.1   29.1   29.9   44.9    0.0   80.9   32.6   71.1  125.0  108.2    0.1   45.1
  2   10/11   11    89.0   65.6   35.4   30.2   49.6    0.0   28.4   89.1   21.2   29.8   26.2    0.0   37.9
      10/12   12    60.4   47.5   35.0   13.9   46.0    0.0   17.5   59.9   12.7   23.4   47.7    1.0   29.1
      10/13   13   114.7   22.4   42.6   16.8   24.9    0.0   51.1   42.2   25.3   57.7   31.9    0.0   33.6
      10/14   14    93.7   41.3   38.3   24.0   86.9    0.0   53.9   45.0   26.2   26.9   24.4    0.0   37.1
      10/15   15   120.3   49.1   30.8   15.5   25.5    0.0   31.3   60.6   25.1   61.9   31.8    0.0   35.0
      10/16   16   124.9   45.7   23.6   12.8   34.9    0.0   29.2   38.7   17.4   35.3   20.0    0.0   30.3
      10/17   17   100.9   79.1   31.2   29.3   24.6    0.0   67.9   54.6   35.5   37.3   78.7    0.0   43.5
  3   10/18   18   147.0   27.4   33.2   10.4   48.0    0.0   34.4   61.8   50.1   95.9   34.0    0.0   42.2
      10/19   19   105.8   38.8   30.1   18.2   92.6    0.0   24.7   61.2   44.3   24.7   31.1    0.0   37.6
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	10/20	20	143.1	46.4	37.2	15.4	84.0	0.0	20.9	29.6	59.9	50.6	29.5	0.0	41.1
	10/21	21	116.4	35.8	22.2	17.1	75.8	0.0	26.0	58.2	49.2	34.3	24.4	1.0	36.7
	10/22	22	96.5	38.5	26.8	11.4	23.4	0.0	20.1	50.8	35.9	104.4	27.9	0.0	32.3
	10/23	23	146.1	24.5	37.3	19.3	87.5	0.0	21.7	0.0	27.3	23.3	28.4	0.0	33.1
4	10/24	24	136.8	69.5	20.5	31.5	38.8	0.0	21.7	0.0	98.6	27.8	52.1	0.0	41.3
	10/25	25	116.5	28.4	62.1	32.9	59.4	0.0	24.6	0.0	56.4	28.6	23.5	0.0	37.1
	10/26	26	169.4	21.8	32.5	15.2	119.3	0.0	26.8	0.0	36.9	103.1	26.2	0.0	40.3
	10/27	27	133.9	27.9	29.4	17.5	50.9	0.0	18.1	0.0	29.2	56.5	45.6	0.0	30.7
	10/28	28	177.0	28.9	30.0	14.5	31.5	0.0	42.3	0.0	36.4	35.9	25.9	0.0	33.8
	10/29	29	170.1	37.9	30.9	19.9	21.6	0.0	21.6	0.0	17.5	35.4	25.5	0.0	30.5
	10/30	30	136.5	56.2	38.4	15.1	20.6	0.0	18.7	9.2	19.6	67.0	23.3	0.0	31.7
	10/31	31	166.4	55.7	27.8	21.1	24.8	0.0	20.3	45.5	55.6	109.2	43.4	0.0	43.2
5	11/ 1	32	174.4	35.5	41.0	20.9	39.6	0.0	87.2	63.5	24.8	65.8	38.7	0.5	46.0
	11/ 2	33	163.8	20.9	28.6	19.6	57.2	0.0	18.2	41.5	31.7	29.8	44.9	0.5	35.6
	11/ 3	34	151.6	48.2	47.4	20.1	77.4	0.0	40.3	36.3	34.2	41.8	56.6	2.4	43.6
	11/ 4	35	188.2	61.3	45.8	19.1	70.1	0.0	27.3	68.3	80.3	58.3	22.5	0.0	52.4
	11/ 5	36	170.0	50.4	29.2	18.7	24.5	0.0	20.8	33.3	28.0	40.3	30.0	0.0	35.6
	11/ 6	37	193.0	31.4	40.6	20.7	25.4	0.0	11.8	29.0	14.5	23.6	27.6	0.5	34.1
	11/ 7	38	175.6	17.8	44.6	27.9	38.6	0.0	74.3	51.4	80.3	23.5	60.0	0.0	48.6
6	11/ 8	39	187.6	39.3	39.0	18.9	59.1	0.0	84.5	31.9	50.4	107.6	22.0	0.0	49.2
	11/ 9	40	113.4	46.7	30.4	14.9	38.7	0.0	21.5	32.4	29.4	27.1	31.5	0.0	31.0
	11/10	41	182.7	45.0	37.7	14.5	63.5	0.0	16.5	47.0	22.2	25.9	22.1	0.0	38.5
	11/11	42	160.7	57.2	29.2	20.6	28.7	0.0	31.9	57.7	43.3	56.7	65.1	0.0	42.5
	11/12	43	161.5	31.9	28.8	21.4	32.1	0.0	34.8	40.4	22.0	30.2	31.5	3.0	35.0
	11/13	44	124.2	67.7	23.1	22.6	23.6	0.0	21.0	30.8	18.7	44.0	28.0	0.0	32.0
	11/14	45	28.6	14.1	29.5	21.4	50.1	0.0	25.5	35.8	37.7	97.2	41.9	0.0	27.3
7	11/15	46	33.3	23.8	40.4	30.9	68.5	0.0	31.1	53.5	45.7	39.7	33.5	0.0	32.2
	11/16	47	20.3	27.1	23.9	16.7	62.3	0.0	24.6	34.7	36.8	34.4	49.0	0.0	25.0
	11/17	48	29.3	33.1	26.0	22.3	103.7	1.0	14.7	35.2	35.4	79.2	23.3	0.0	29.7
	11/18	49	26.2	27.1	31.2	18.7	41.4	0.0	24.1	32.3	23.8	40.4	50.4	0.0	23.8
	11/19	50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	11/20	51	30.1	37.6	37.7	24.9	51.4	0.0	16.3	58.1	13.6	37.9	15.3	0.5	26.1
	11/21	52	29.7	48.5	43.0	20.7	52.8	0.0	48.2	70.9	100.6	93.4	74.9	0.0	44.8
8	11/22	53	30.5	11.8	39.0	24.0	45.0	0.0	64.0	80.0	67.0	55.2	42.5	0.0	36.4
	11/23	54	40.7	25.1	24.7	16.2	54.2	0.0	78.2	48.2	31.4	38.9	36.0	0.5	30.4
	11/24	55	37.2	21.5	30.1	13.9	39.9	0.0	65.8	38.1	21.9	20.5	32.2	1.2	25.6
	11/25	56	35.3	18.9	31.3	19.4	36.6	0.0	30.0	47.4	42.7	165.0	51.7	0.7	32.3
	11/26	57	20.5	44.6	30.4	23.6	42.5	0.0	32.5	45.8	65.4	101.5	72.1	1.7	35.2
	11/27	58	21.9	89.8	63.3	24.2	81.5	0.0	26.7	66.4	66.5	86.2	72.6	2.5	46.9
	11/28	59	23.1	50.4	29.3	21.1	103.8	0.0	23.5	32.5	61.0	88.8	47.6	0.0	35.7
9	11/29	60	41.1	19.9	31.1	25.2	30.7	0.0	82.6	41.4	35.2	44.0	42.3	0.0	30.7
	11/30	61	21.3	30.5	20.5	13.3	75.5	0.0	36.9	23.6	22.2	22.9	27.6	0.0	22.7
	12/ 1	62	44.1	27.0	30.2	24.9	63.6	36.7	18.8	47.8	24.6	35.5	27.5	0.5	28.0
	12/ 2	63	27.5	33.4	32.2	23.1	20.4	2.7	24.7	28.4	32.5	26.4	48.3	3.0	24.3
	12/ 3	64	24.9	30.7	36.0	18.7	35.4	11.6	16.3	23.0	29.6	39.8	24.6	3.9	23.6
	12/ 4	65	13.8	21.2	43.8	18.2	59.4	16.7	15.6	33.0	17.5	28.4	20.6	11.9	24.5
	12/ 5	66	31.9	39.1	30.6	34.4	29.9	60.6	53.5	39.1	63.7	31.4	60.5	29.9	41.0
10	12/ 6	67	32.1	23.2	48.1	19.0	72.4	26.8	36.9	79.0	62.1	127.4	36.6	33.3	45.6
	12/ 7	68	22.6	20.2	29.5	16.0	49.3	48.4	17.7	31.7	26.9	32.3	20.9	38.0	29.0
	12/ 8	69	39.8	22.6	30.0	14.3	61.7	57.8	16.6	40.7	18.8	50.9	20.9	33.8	31.9
	12/ 9	70	45.2	22.1	38.7	16.5	48.0	36.7	13.2	33.3	19.1	29.7	30.5	33.9	30.0
	12/10	71	20.6	45.7	51.0	11.4	31.6	37.3	17.8	28.5	19.7	26.3	33.2	40.4	30.9
	12/11	72	37.7	26.7	35.4	23.1	29.1	60.2	12.5	30.5	21.6	63.7	14.5	29.9	30.8
	12/12	73	29.7	40.7	33.3	22.2	60.1	52.0	14.8	28.0	43.3	30.7	59.1	43.8	36.9
11	12/13	74	38.7	24.0	37.8	18.3	56.3	64.4	46.3	55.4	80.6	48.2	34.9	37.8	42.3
	12/14	75	21.9	26.4	34.8	20.8	46.2	37.9	26.5	39.5	34.0	82.8	52.2	36.8	35.0
	12/15	76	27.9	28.8	50.4	16.8	53.1	47.5	11.9	29.7	24.6	46.4	29.3	30.4	32.1
	12/16	77	21.0	49.7	27.2	15.6	41.2	48.3	18.7	24.1	21.2	43.4	24.0	38.6	30.2
	12/17	78	39.1	52.6	35.0	15.0	40.1	37.4	12.6	33.7	25.4	62.3	26.3	33.4	33.0
	12/18	79	33.8	72.4	36.2	25.5	62.6	40.0	19.3	30.3	23.1	29.2	27.1	39.7	36.8
	12/19	80	28.4	30.9	27.6	24.8	34.9	41.0	23.1	25.6	62.0	44.5	44.5	23.1	33.0
12	12/20	81	30.4	43.2	41.2	16.7	45.3	55.6	56.4	37.3	61.6	49.6	37.1	39.2	42.1

	12/21	82	32.6	29.1	70.9	16.5	138.4	55.9	20.2	38.1	32.5	31.5	46.1	25.2	42.8
	12/22	83	21.5	36.2	39.3	18.2	43.8	71.9	18.6	57.9	28.0	58.5	33.8	26.5	35.5
	12/23	84	32.3	26.9	34.9	14.5	61.5	53.9	20.6	40.9	21.3	96.2	51.6	34.3	35.7
	12/24	85	52.8	61.8	46.3	23.9	19.8	37.9	43.2	38.8	66.7	113.4	61.7	40.5	47.5
	12/25	86	53.6	61.4	35.8	22.4	49.7	81.5	52.3	38.4	14.3	98.6	63.9	56.8	47.5
	12/26	87	46.8	43.5	32.7	17.0	33.1	54.6	35.8	35.6	28.5	60.9	17.6	37.2	35.3
13	12/27	88	33.0	37.8	46.2	30.2	39.2	60.7	35.2	34.9	32.9	41.5	0.0	38.4	37.0
	12/28	89	29.5	53.1	32.6	15.1	37.1	45.8	56.0	63.3	36.7	29.9	16.9	39.3	38.4
	12/29	90	26.7	31.8	31.3	17.8	66.7	50.7	24.7	42.1	31.3	64.8	41.5	37.0	36.4
	12/30	91	32.5	45.9	28.9	16.6	49.6	56.2	54.0	25.7	67.0	30.5	32.2	37.2	39.7
	12/31	92	34.3	70.4	29.6	21.4	21.6	60.6	40.4	64.1	53.1	93.3	103.7	25.6	45.6
	1/ 1	93	38.4	38.5	43.1	23.8	71.4	50.3	21.3	51.6	60.8	43.4	39.9	44.4	43.5
	1/ 2	94	43.4	44.5	24.4	20.0	60.8	66.5	66.2	53.6	60.9	40.7	79.1	29.9	45.6
14	1/ 3	95	31.8	16.6	45.7	42.0	55.9	48.3	40.1	40.9	34.6	40.7	41.7	35.3	38.7
	1/ 4	96	26.4	51.9	27.9	18.4	47.9	54.5	22.5	36.0	43.0	35.6	31.0	22.8	33.5
	1/ 5	97	25.8	81.9	47.7	16.5	40.2	37.8	19.3	27.3	34.7	33.1	24.9	30.9	35.8
	1/ 6	98	26.2	46.5	29.5	13.3	56.3	32.7	29.0	47.9	24.8	32.7	24.6	25.0	31.4
	1/ 7	99	30.3	15.8	42.2	16.5	35.3	71.6	19.2	35.3	24.4	30.8	39.5	34.5	32.1
	1/ 8	100	26.4	20.9	40.6	16.0	73.3	75.6	33.8	39.3	36.9	75.4	64.5	27.9	39.3
	1/ 9	101	44.3	37.7	31.5	20.8	77.0	30.3	26.9	39.2	44.4	48.6	93.6	26.2	39.1
15	1/10	102	33.1	21.4	33.0	23.5	63.0	75.1	68.9	50.0	34.5	62.8	63.9	35.4	42.8
	1/11	103	38.2	49.3	28.5	13.6	62.1	36.7	59.1	32.3	28.9	25.6	45.7	32.7	36.3
	1/12	104	31.4	43.3	31.2	26.2	82.8	20.6	23.6	47.2	25.9	28.3	38.7	23.7	33.9
	1/13	105	28.3	38.9	46.2	13.3	42.6	27.9	22.1	44.8	37.0	53.8	51.8	31.5	34.5
	1/14	106	30.5	57.9	34.9	21.6	31.7	38.5	21.3	28.4	41.6	24.4	71.1	39.3	36.0
	1/15	107	30.3	43.5	32.0	15.1	23.3	54.6	13.9	35.5	32.3	26.7	63.4	33.4	32.2
	1/16	108	28.1	45.9	34.6	27.3	28.5	36.4	32.9	37.1	73.8	163.0	98.6	34.0	46.3
16	1/17	109	45.6	48.1	43.0	19.4	94.4	56.5	62.2	54.9	36.3	48.8	53.2	39.2	47.4
	1/18	110	14.2	36.9	28.3	18.9	30.0	42.4	19.4	23.5	21.1	25.2	28.4	38.5	27.3
	1/19	111	41.3	55.4	54.2	15.8	24.0	42.2	27.4	29.6	27.3	31.7	35.7	28.6	34.6
	1/20	112	32.4	29.0	29.7	18.8	37.1	11.9	15.6	37.7	29.7	45.6	33.2	25.7	27.8
	1/21	113	58.6	50.5	37.1	17.0	31.3	44.0	27.1	26.6	18.0	71.4	27.4	32.5	34.8
	1/22	114	19.4	39.5	41.4	16.4	28.9	40.0	15.1	32.1	46.5	110.4	23.1	24.9	33.6
	1/23	115	37.2	22.7	37.6	23.7	83.0	36.3	21.8	60.2	60.7	130.1	74.1	23.9	44.2
17	1/24	116	38.2	31.1	31.8	19.6	63.8	38.3	20.1	43.4	41.7	75.9	30.7	39.6	37.2
	1/25	117	38.3	46.0	39.6	18.9	32.8	44.1	65.3	24.9	44.8	60.3	25.7	34.1	38.8
	1/26	118	22.6	31.6	41.5	19.4	53.7	40.0	27.4	32.6	23.7	90.1	24.0	33.0	33.9
	1/27	119	22.8	42.1	25.7	24.4	26.0	36.2	30.2	28.2	36.9	46.9	23.2	32.6	30.9
	1/28	120	27.2	41.3	38.6	16.3	23.6	34.3	23.3	47.9	19.6	151.3	21.3	32.5	34.9
	1/29	121	26.8	79.9	39.3	27.4	28.5	34.7	33.8	30.3	16.7	49.1	74.3	42.7	38.4
	1/30	122	26.3	32.6	31.1	36.3	30.9	32.8	92.0	41.0	49.3	60.5	42.5	35.8	41.3
18	1/31	123	44.7	23.4	55.7	24.5	78.0	67.8	66.8	54.9	59.6	88.0	39.3	34.9	50.2
	2/ 1	124	42.4	24.2	29.0	21.0	24.4	27.6	17.1	33.8	30.2	94.3	35.7	30.1	31.0
	2/ 2	125	33.2	27.1	27.6	15.6	24.6	92.7	21.3	28.6	27.1	93.9	43.7	28.8	33.9
	2/ 3	126	25.3	72.1	25.8	18.3	35.5	61.9	22.2	40.7	22.8	88.8	23.1	32.0	36.1
	2/ 4	127	31.2	73.5	34.0	18.7	33.4	64.7	22.5	36.3	28.8	85.5	21.3	43.1	39.2
	2/ 5	128	23.9	51.1	68.5	9.0	22.7	38.7	16.9	42.3	19.0	52.2	22.9	25.4	32.8
	2/ 6	129	17.4	32.1	33.3	18.9	70.0	55.0	28.4	30.8	65.1	213.2	100.3	30.5	46.7
19	2/ 7	130	39.6	15.1	50.5	10.4	84.9	40.1	54.1	63.3	33.6	154.2	45.2	34.0	45.1
	2/ 8	131	31.3	27.8	34.5	15.0	53.6	37.5	47.1	27.6	52.1	77.4	38.4	32.6	37.0
	2/ 9	132	39.8	34.3	45.1	13.1	34.0	50.8	16.5	19.8	23.2	78.6	32.4	34.8	32.8
	2/10	133	25.0	41.3	42.2	14.8	19.6	19.3	22.1	14.9	29.1	88.2	29.6	42.4	31.3
	2/11	134	31.3	75.1	28.9	11.9	32.5	60.8	18.5	34.5	20.3	88.9	23.5	29.4	34.9
	2/12	135	44.5	20.0	32.8	25.4	46.1	28.3	40.3	36.4	21.7	94.1	33.8	28.8	34.1
	2/13	136	34.8	58.5	23.7	18.0	35.8	64.8	30.9	73.3	67.1	112.4	63.4	28.2	45.6
20	2/14	137	60.7	27.2	22.9	25.4	90.9	73.1	49.8	72.7	56.2	60.9	23.5	30.9	46.9
	2/15	138	40.1	37.4	44.6	18.6	35.0	75.1	24.7	34.6	57.4	78.8	32.5	36.9	41.1
	2/16	139	37.1	27.0	30.6	15.2	31.9	62.9	19.5	28.4	25.3	56.1	31.4	29.7	30.7
	2/17	140	31.1	55.8	30.5	14.0	41.5	48.0	29.7	28.8	25.1	62.7	24.9	31.4	33.4
	2/18	141	27.0	51.4	43.3	19.3	16.8	52.6	16.5	46.5	23.0	58.7	32.6	27.1	33.2
	2/19	142	25.3	26.0	38.1	17.7	28.7	50.0	4.0	24.4	28.4	161.1	24.6	30.7	33.0
	2/20	143	31.0	28.6	31.5	25.6	34.1	74.6	14.3	44.6	78.4	68.0	57.9	31.5	40.8

21	2/21	144	40.8	107.7	41.4	21.2	94.1	85.0	52.0	60.8	57.6	68.7	50.4	27.3	55.7
	2/22	145	35.4	14.0	39.8	22.2	27.1	83.2	26.1	27.3	24.8	39.1	28.1	41.1	33.2
	2/23	146	32.0	29.2	27.0	13.7	25.4	45.4	18.7	48.3	21.3	75.3	31.0	29.7	30.2
	2/24	147	24.0	52.8	29.2	11.4	27.5	86.3	21.8	22.8	18.5	76.0	27.0	30.9	32.5
	2/25	148	28.3	57.6	40.0	21.3	17.8	53.2	24.4	31.6	31.1	45.6	32.4	33.9	34.4
	2/26	149	14.2	40.4	30.3	14.9	60.0	44.6	12.3	21.1	26.9	105.9	44.8	34.0	32.7
	2/27	150	15.5	41.2	32.3	105.9	35.5	44.1	37.6	33.0	61.3	77.6	35.9	32.2	46.2
22	2/28	151	40.4	31.2	60.0	22.4	85.2	115.1	72.8	72.0	28.4	76.2	32.8	30.9	51.8
	3/ 1	152	25.8	45.2	30.8	12.8	47.1	63.3	31.5	26.8	20.9	31.0	38.7	39.3	33.1
	3/ 2	153	22.9	21.7	44.9	10.7	30.7	84.5	29.2	24.6	18.2	32.0	22.8	44.5	31.9
	3/ 3	154	30.6	22.9	28.3	16.9	32.3	41.8	19.8	39.9	19.5	37.9	25.3	32.9	28.1
	3/ 4	155	20.1	28.7	38.7	24.2	40.1	49.8	37.0	29.6	22.3	72.9	32.6	33.4	34.2
	3/ 5	156	37.8	20.9	35.6	17.4	22.2	72.1	40.9	28.4	39.6	55.4	67.3	38.9	36.7
23	3/ 6	157	31.2	56.2	39.5	35.7	40.6	54.6	14.7	64.3	57.8	125.5	84.1	54.8	50.3
	3/ 7	158	38.1	35.5	48.4	23.2	29.6	50.9	29.0	36.3	28.7	64.3	31.1	32.8	36.1
	3/ 8	159	23.9	40.2	37.0	17.3	23.6	54.8	23.8	25.5	21.2	36.8	31.3	39.9	30.9
	3/ 9	160	35.3	51.1	35.1	23.4	112.2	27.4	15.9	32.9	18.9	69.1	26.4	34.6	37.5
	3/10	161	22.4	31.6	36.7	16.5	22.4	44.0	15.1	28.6	18.2	42.0	38.9	41.7	30.0
	3/11	162	34.9	41.7	52.6	19.9	19.6	39.5	22.2	49.6	20.3	30.8	26.8	27.3	32.5
	3/12	163	48.0	44.0	36.7	22.1	19.8	50.1	18.9	29.9	13.6	134.5	32.2	34.1	35.5
	3/13	164	50.3	36.7	39.5	33.3	36.8	179.1	29.0	65.8	39.7	50.5	65.0	25.4	49.6
24	3/14	165	61.3	39.5	44.2	18.9	63.9	32.8	64.5	43.2	28.3	62.7	54.5	36.3	43.0
	3/15	166	40.3	32.5	39.5	18.4	28.0	24.2	30.0	30.7	61.2	32.3	28.8	33.7	34.8
	3/16	167	52.5	49.6	39.9	16.3	26.4	50.9	12.4	28.9	18.4	54.5	29.5	34.4	35.9
	3/17	168	36.3	31.2	34.1	16.9	37.4	43.7	15.6	34.0	22.5	33.5	29.1	30.9	29.7
	3/18	169	20.3	59.9	40.2	21.3	42.4	53.6	53.1	22.1	20.7	32.1	28.4	38.5	36.0
	3/19	170	32.0	63.4	38.4	21.7	29.6	91.7	12.3	26.8	18.6	47.0	25.3	34.8	35.7
	3/20	171	37.1	43.3	35.8	34.0	36.5	56.1	19.2	43.6	38.9	61.9	67.6	34.2	39.6
25	3/21	172	41.9	13.6	36.8	42.8	122.0	56.1	49.3	70.9	50.2	65.4	36.0	40.5	49.6
	3/22	173	20.8	37.4	34.4	17.0	75.5	36.6	31.2	42.8	29.6	52.4	26.5	26.5	34.0
	3/23	174	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3/24	175	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3/25	176	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3/26	177	30.8	46.3	36.7	18.0	31.0	55.9	22.0	21.6	35.0	90.2	27.2	35.2	35.1
26	3/27	178	25.7	33.2	45.2	31.1	56.0	55.4	35.8	33.0	64.9	46.4	107.6	22.8	42.6
	3/28	179	27.9	11.4	55.6	29.5	27.4	66.4	58.5	66.0	58.1	70.1	41.9	28.9	43.5
	3/29	180	23.9	53.5	26.0	19.7	39.4	45.9	21.5	20.0	21.1	49.4	30.1	30.2	30.2
	3/30	181	22.8	28.1	30.1	19.0	40.6	68.1	16.6	24.7	27.4	45.5	39.8	29.4	30.5
	3/31	182	27.8	43.6	51.7	23.1	22.4	60.3	25.9	28.4	21.0	59.3	16.6	33.2	34.1
	4/ 1	183	37.3	45.9	32.7	23.4	30.4	39.4	26.8	18.0	35.2	33.7	36.8	31.1	32.2
	4/ 2	184	30.6	49.0	32.4	18.9	30.9	37.7	22.1	24.7	31.2	86.6	28.9	29.8	32.8
	4/ 3	185	26.9	50.0	34.0	23.4	71.4	42.1	34.6	49.4	45.7	78.9	72.4	41.0	43.5
27	4/ 4	186	39.9	18.9	57.1	34.7	51.4	42.6	46.0	63.4	37.6	48.2	24.8	34.4	41.6
	4/ 5	187	17.0	47.3	38.7	23.1	70.7	34.0	16.3	28.7	27.7	28.2	26.6	22.0	31.2
	4/ 6	188	29.6	49.6	35.7	26.4	54.5	105.1	43.2	36.4	18.4	31.5	27.3	25.8	38.5
	4/ 7	189	23.3	28.4	37.9	27.0	26.8	25.4	29.9	33.7	19.2	47.6	29.0	25.6	32.7
	4/ 8	190	42.9	44.5	27.3	25.8	25.4	28.8	53.3	25.7	31.7	50.4	18.0	45.5	35.1
	4/ 9	191	30.3	46.6	42.9	39.4	34.8	42.2	43.2	44.7	11.0	121.5	63.8	33.8	44.3
	4/10	192	28.8	16.8	42.2	49.2	57.2	34.9	24.1	0.0	57.6	47.8	38.2	28.3	35.2
28	4/11	193	48.4	24.3	34.7	26.7	75.0	67.8	62.7	11.5	33.7	0.0	58.1	31.5	39.1
	4/12	194	20.5	45.2	37.9	26.1	19.3	95.1	21.2	34.9	29.6	27.6	39.3	31.0	34.9
	4/13	195	34.4	57.4	52.5	25.5	40.3	54.8	17.5	56.7	32.6	36.1	62.6	32.4	40.7
	4/14	196	37.8	51.2	36.6	25.0	19.9	111.5	34.7	35.4	48.1	34.2	63.9	40.8	43.2
	4/15	197	50.1	41.5	45.9	32.6	38.1	51.5	23.0	36.2	54.6	70.9	70.5	43.0	44.2
	4/16	198	45.8	47.0	34.7	26.6	35.8	73.0	39.9	43.3	26.7	28.9	35.0	33.2	38.3
	4/17	199	43.6	17.1	47.7	21.5	20.2	54.7	35.6	48.3	27.0	76.3	0.0	33.4	34.7
29	4/18	200	48.9	25.3	43.3	22.5	36.9	42.7	30.0	36.5	33.9	46.7	7.4	43.2	35.5
	4/19	201	33.8	32.9	40.8	19.9	69.7	0.0	23.3	43.2	48.4	35.6	32.9	37.9	35.2
	4/20	202	41.5	72.7	35.4	23.5	36.9	0.0	18.9	26.6	40.3	29.4	41.8	35.0	34.3
	4/21	203	26.4	30.4	49.4	24.6	28.3	0.0	22.2	39.0	31.3	64.9	27.8	35.5	32.2
	4/22	204	54.3	49.1	20.1	14.9	31.8	4.8	25.4	30.6	31.7	31.3	26.2	40.7	31.1
	4/23	205	50.4	32.2	47.4	24.5	34.6	31.0	32.8	24.0	21.6	66.2	32.7	32.8	38.3

	4/24	206	28.9	0.0	32.4	25.9	38.8	55.1	27.8	51.5	70.4	36.3	83.4	40.4	40.1
30	4/25	207	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4/26	208	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4/27	209	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4/28	210	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4/29	211	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	4/30	212	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 1	213	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	5/ 2	214	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 3	215	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 4	216	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 5	217	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 6	218	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 7	219	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/ 8	220	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	5/ 9	221	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/10	222	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/11	223	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/12	224	46.3	35.5	43.1	17.9	23.1	88.7	22.4	28.3	24.8	27.0	36.9	38.6	36.2
	5/13	225	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/14	226	23.0	23.9	28.7	20.0	9.4	15.4	15.4	22.0	40.3	29.4	31.4	36.3	25.4
	5/15	227	60.0	37.9	36.2	28.7	6.3	0.0	35.5	59.1	66.9	109.6	65.2	57.1	44.7
33	5/16	228	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/17	229	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/18	230	49.0	69.5	33.3	20.9	1.8	0.0	26.1	32.9	71.0	52.6	84.1	51.7	40.7
	5/19	231	39.6	118.6	29.5	19.2	5.6	0.0	15.3	39.7	44.8	37.4	38.4	39.3	37.1
	5/20	232	34.9	66.0	59.2	26.3	0.9	0.0	47.4	32.4	60.6	30.2	43.1	39.1	39.4
	5/21	233	44.7	41.6	38.6	27.9	3.8	0.0	21.0	22.4	30.2	26.9	37.4	41.6	29.6
	5/22	234	94.7	103.2	31.7	20.7	1.4	0.0	26.8	37.1	66.0	109.2	69.3	37.6	47.1
34	5/23	235	74.8	75.3	41.6	25.3	24.8	0.0	49.7	87.1	37.2	56.6	56.5	37.5	46.3
	5/24	236	62.5	93.2	38.4	19.0	2.5	0.0	24.5	20.3	38.0	52.2	51.4	27.4	39.3
	5/25	237	46.0	58.9	33.5	16.0	5.7	0.0	38.8	33.7	57.1	32.9	43.6	37.3	34.7
	5/26	238	71.4	30.0	34.9	18.9	3.7	0.0	23.1	47.3	30.1	75.4	37.6	30.3	32.0
	5/27	239	62.5	44.9	30.8	25.6	3.2	0.0	45.1	22.7	26.1	31.9	48.3	39.7	32.4
	5/28	240	70.1	74.3	38.8	24.5	6.5	0.0	20.4	22.3	38.2	63.0	23.1	41.1	36.1
	5/29	241	58.4	52.7	47.7	57.7	22.5	0.0	53.4	38.0	49.1	48.4	50.8	35.9	43.8
35	5/30	242	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	5/31	243	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6/ 1	244	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6/ 2	245	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6/ 3	246	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6/ 4	247	78.2	45.2	42.0	23.0	35.6	1.6	15.8	29.4	43.1	37.7	64.6	34.1	36.8
	6/ 5	248	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6/ 6	249	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	6/ 7	250	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	6/ 8	251	54.3	45.2	40.9	21.8	90.9	0.0	22.6	33.5	30.3	42.1	33.2	64.4	40.3
	6/ 9	252	82.8	33.6	35.0	33.7	53.7	0.0	24.7	52.8	45.5	37.1	28.3	45.0	40.2
	6/10	253	58.7	62.8	30.2	22.3	27.2	0.0	31.3	36.3	84.6	109.7	40.7	45.3	44.3
	6/11	254	97.9	31.7	37.6	29.5	37.7	0.0	28.0	37.4	111.3	35.1	21.0	39.9	45.1
	6/12	255	90.9	37.4	51.8	35.9	37.0	10.0	36.2	22.6	67.9	88.5	65.2	43.5	47.3
37	6/13	256	62.6	26.9	38.3	27.2	34.8	0.0	61.8	76.7	31.6	30.3	31.6	53.5	40.7
	6/14	257	42.0	58.5	27.6	22.5	24.2	0.0	32.7	20.4	27.6	34.9	29.5	30.9	29.6
	6/15	258	49.1	52.8	47.7	32.8	180.1	1.0	26.1	31.2	55.3	49.2	31.8	45.2	49.3
	6/16	259	56.3	45.2	30.9	24.8	36.8	0.0	27.5	27.6	25.7	81.9	15.5	45.8	34.1
	6/17	260	61.1	52.8	73.8	24.9	29.5	0.0	29.2	21.7	31.9	38.2	33.1	45.6	39.1
	6/18	261	68.2	41.1	36.2	19.2	39.6	0.0	39.8	20.4	40.8	29.5	30.2	44.7	35.2
	6/19	262	67.8	62.7	35.8	49.7	24.9	0.0	50.1	56.7	56.5	119.2	95.7	43.1	50.9
38	6/20	263	78.2	33.4	40.9	24.3	37.1	0.0	85.5	80.6	29.3	134.9	44.0	40.4	47.8
	6/21	264	68.2	41.1	46.2	25.8	55.4	0.0	36.1	30.3	21.6	51.8	65.5	47.5	39.3
	6/22	265	69.0	55.9	39.6	23.2	80.6	0.0	27.5	22.3	22.0	73.3	41.0	32.5	38.1
	6/23	266	76.3	36.0	34.6	26.5	64.9	0.0	27.3	24.2	33.3	83.7	36.6	50.9	39.4
	6/24	267	72.0	37.4	31.4	39.1	17.0	1.0	27.9	50.0	69.7	129.8	37.8	54.3	45.3

	6/25	268	87.0	66.0	26.7	27.2	24.5	0.0	18.8	27.2	49.3	53.9	26.9	56.8	39.3
39	6/26	269	0.0	42.7	48.9	0.0	42.7	0.0	33.6	58.9	45.6	27.0	61.5	47.4	34.3
	6/27	270	23.9	45.8	38.0	0.0	85.1	0.0	50.1	30.1	45.8	40.7	29.0	41.4	35.6
	6/28	271	91.8	31.8	34.7	0.5	20.6	0.0	39.3	42.6	45.0	21.0	37.8	40.2	34.4
	6/29	272	77.7	43.1	31.0	0.0	83.1	1.1	65.7	35.3	28.2	111.0	41.4	54.5	43.3
	6/30	273	66.1	24.3	53.2	0.0	40.4	0.0	46.9	44.9	103.5	52.0	31.2	49.4	57.8
	7/ 1	274	49.6	54.8	48.9	0.0	33.1	0.0	58.4	28.9	48.3	61.3	33.7	44.2	38.9
	7/ 2	275	30.4	44.9	39.9	1.4	61.7	0.8	30.0	70.0	46.4	132.5	84.3	31.6	41.2
	7/ 3	276	47.0	32.9	35.6	0.6	68.3	0.0	18.4	67.0	45.7	77.2	89.1	55.4	40.7
40	7/ 4	277	40.2	33.1	30.0	0.0	22.0	10.0	32.1	63.3	10.5	69.5	41.7	66.0	33.2
	7/ 5	278	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	7/ 6	279	36.3	72.8	39.3	0.0	33.5	0.0	27.0	37.6	56.6	131.2	35.0	88.7	45.2
	7/ 7	280	34.0	40.2	52.5	0.0	34.9	0.0	32.6	29.4	56.1	25.6	33.6	73.0	41.4
	7/ 8	281	55.2	74.1	33.9	0.0	29.2	0.0	26.1	32.9	50.5	46.5	37.2	65.2	38.6
	7/ 9	282	56.5	67.9	49.2	38.0	19.8	0.0	35.0	59.6	36.3	56.6	25.6	56.6	43.7
	7/10	283	37.0	32.6	35.7	36.3	57.6	0.0	34.0	57.6	39.0	98.7	81.4	63.0	44.3
41	7/11	284	40.4	11.6	41.0	23.3	21.8	0.0	57.1	38.7	57.4	49.9	39.2	54.6	37.6
	7/12	285	60.3	55.1	32.7	20.7	14.0	0.0	36.0	37.3	52.6	51.0	50.7	48.2	39.4
	7/13	286	57.2	47.6	50.0	22.8	52.8	0.0	42.1	101.5	79.0	36.2	29.1	42.7	48.6
	7/14	287	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	7/15	288	45.7	40.6	25.4	22.6	29.4	0.0	57.7	41.2	44.0	57.6	153.4	51.0	42.0
	7/16	289	54.0	32.3	24.1	34.0	57.8	0.0	41.3	56.2	39.3	49.6	72.3	49.4	40.3
	7/17	290	43.8	68.5	27.5	29.2	11.2	0.0	41.3	91.5	59.8	59.9	49.4	38.1	43.0
42	7/18	291	47.2	30.6	46.8	34.2	31.9	0.0	26.5	108.5	35.6	22.3	66.1	29.9	39.7
	7/19	292	61.6	40.5	22.9	24.4	16.5	0.0	41.2	74.5	64.7	36.2	29.1	33.3	37.9
	7/20	293	32.1	40.4	31.9	20.9	10.4	0.0	39.8	25.7	38.1	72.1	26.5	46.9	32.0
	7/21	294	54.9	24.3	51.2	22.5	34.5	0.0	47.1	36.6	24.1	67.6	33.6	28.8	34.1
	7/22	295	34.9	58.2	45.8	19.0	9.4	0.0	50.3	28.4	64.2	58.8	54.6	37.9	39.0
	7/23	296	103.2	64.5	47.9	22.3	27.1	0.0	39.4	29.5	31.0	27.6	37.4	38.6	40.3
	7/24	297	56.0	57.1	33.0	32.1	103.3	0.0	83.8	35.8	40.8	126.9	55.1	56.0	52.0
43	7/25	298	64.5	25.0	33.7	33.0	19.7	0.0	46.4	63.0	50.6	39.7	48.6	40.9	39.0
	7/26	299	24.2	43.0	33.7	22.4	45.3	0.0	44.7	54.8	31.7	34.6	28.1	44.9	34.6
	7/27	300	50.4	37.6	40.7	17.1	36.6	0.0	25.8	82.1	30.3	25.2	26.3	21.5	33.2
	7/28	301	61.0	32.4	32.0	18.0	43.1	0.0	29.0	56.6	19.0	33.9	27.1	28.6	31.3
	7/29	302	37.8	43.5	29.4	14.6	26.3	0.0	52.7	14.6	46.9	22.7	30.4	34.0	30.5
	7/30	303	51.2	36.7	32.8	15.3	14.8	0.0	39.1	2.3	14.7	87.5	19.3	34.1	27.5
	7/31	304	57.2	31.3	32.3	24.3	21.5	0.0	65.0	2.8	37.7	66.1	67.1	38.8	34.8
44	8/ 1	305	43.8	48.5	40.7	27.2	14.0	0.0	55.0	7.8	36.8	49.9	56.0	36.1	33.7
	8/ 2	306	56.6	47.0	27.4	16.0	59.9	0.0	33.9	2.2	24.5	49.9	31.0	30.9	30.4
	8/ 3	307	42.8	61.8	45.3	15.4	34.1	0.0	31.0	17.2	47.8	31.8	22.2	44.5	35.0
	8/ 4	308	70.9	18.4	33.3	19.0	33.2	0.0	19.0	52.4	15.0	33.3	24.9	27.6	28.6
	8/ 5	309	87.2	17.1	31.5	16.4	113.5	0.0	24.2	52.1	40.0	117.6	51.4	40.2	43.6
	8/ 6	310	80.4	30.2	27.4	73.2	19.6	0.0	21.1	63.4	24.3	29.9	35.9	37.2	37.8
45	8/ 7	311	53.9	65.0	39.3	28.6	115.2	0.0	32.8	28.1	38.5	53.7	48.8	32.0	42.8
	8/ 8	312	63.3	33.3	17.4	56.5	83.0	0.0	53.1	74.3	46.6	60.4	42.0	30.3	44.7
	8/ 9	313	51.7	61.6	36.9	28.9	34.9	0.0	28.6	40.5	48.9	72.7	28.8	42.3	39.5
	8/10	314	81.5	63.3	62.3	25.5	36.0	0.0	41.8	52.4	49.2	80.3	25.5	42.0	48.4
	8/11	315	74.4	63.5	41.2	29.1	22.0	0.0	22.4	42.8	29.4	31.0	33.9	30.1	37.8
	8/12	316	64.3	29.3	58.9	26.0	32.1	0.0	20.2	29.4	40.9	107.9	40.0	29.5	37.3
	8/13	317	84.1	29.8	39.3	23.3	32.1	0.0	32.8	67.6	23.7	59.2	53.1	25.2	36.9
	8/14	318	75.8	34.1	41.0	30.6	33.9	0.0	62.9	41.1	19.0	62.2	56.4	39.4	39.5
46	8/15	319	72.5	21.1	47.7	41.4	43.5	0.0	41.7	59.1	37.3	60.6	42.4	45.2	42.4
	8/16	320	105.7	45.8	40.0	48.1	0.0	0.0	43.8	29.6	27.2	57.7	35.2	45.0	40.9
	8/17	321	78.1	39.5	58.5	25.2	1.3	0.0	20.0	39.5	45.4	68.0	36.6	29.5	37.0
	8/18	322	53.2	14.7	33.9	23.4	13.6	0.0	16.1	34.0	41.3	116.0	21.4	43.8	32.2
	8/19	323	41.6	46.6	44.7	32.2	54.4	0.0	23.9	29.3	30.1	103.6	37.1	40.4	38.2
	8/20	324	35.5	37.5	37.4	30.5	25.3	0.0	20.0	33.1	35.0	55.7	17.3	48.6	32.5
	8/21	325	47.0	40.3	27.4	42.4	13.8	0.0	71.3	46.3	45.8	0.0	0.0	56.0	37.8
47	8/22	326	62.6	39.8	8.4	76.0	5.2	0.0	38.5	46.4	33.7	0.0	17.4	96.4	40.9
	8/23	327	37.0	20.9	21.9	32.5	19.3	0.0	27.1	48.3	14.5	27.5	73.2	37.1	28.4
	8/24	328	46.3	26.4	74.6	22.7	27.3	0.0	31.3	30.8	38.5	48.6	51.9	43.6	37.7
	8/25	329	65.6	21.0	31.7	18.5	47.7	0.0	32.3	28.5	43.7	77.1	51.5	48.8	36.6

	8/26	330	48.4	27.7	38.0	29.4	58.6	0.0	17.8	34.5	43.2	73.7	24.1	30.9	34.5
	8/27	331	26.5	25.8	32.8	36.9	53.2	0.0	32.8	78.3	34.5	57.7	35.1	32.2	36.1
	8/28	332	55.0	23.5	60.6	37.4	18.6	3.7	46.2	39.0	47.5	106.9	57.0	35.6	42.1
48	8/29	333	51.9	30.8	29.5	42.6	74.1	0.0	73.1	65.3	44.8	45.0	28.1	37.7	43.4
	8/30	334	35.4	49.6	29.4	28.7	31.4	1.0	29.9	38.3	37.5	50.6	33.0	41.7	34.0
	8/31	335	38.3	16.9	64.6	49.1	24.1	0.0	35.7	40.7	60.9	36.3	71.3	52.2	42.4
	9/ 1	336	30.9	15.1	30.5	21.7	26.5	0.0	30.5	49.7	57.1	115.2	65.9	62.1	38.8
	9/ 2	337	24.8	21.1	55.0	20.5	31.1	0.0	34.0	64.0	49.2	56.1	24.1	35.6	35.4
	9/ 3	338	33.9	[illegible]	33.7	34.3	58.0	0.0	35.9	53.1	46.9	55.5	65.2	36.8	37.4
	9/ 4	339	13.1	25.6	36.3	21.9	53.5	0.0	57.6	38.9	65.6	54.6	52.3	49.1	38.6
49	9/ 5	340	43.9	36.0	15.8	30.8	0.0	0.0	106.2	60.3	35.1	139.3	54.5	48.0	42.6
	9/ 6	341	42.3	56.9	15.7	66.3	0.0	0.0	82.9	91.5	35.8	93.2	43.8	58.0	47.9
	9/ 7	342	36.2	26.9	49.6	20.4	16.6	0.0	45.8	34.1	58.9	31.6	35.3	49.7	35.9
	9/ 8	343	42.3	17.4	48.2	25.4	41.8	0.0	82.7	35.6	46.2	63.4	31.3	55.4	41.1
	9/ 9	344	44.8	47.0	49.7	21.9	32.4	0.0	40.8	53.5	53.3	98.2	47.2	46.4	43.0
	9/10	345	38.8	100.8	45.9	14.4	88.5	0.0	41.9	20.6	32.3	42.2	29.1	46.7	48.0
	9/11	346	61.4	145.1	35.9	32.7	2.4	0.0	28.9	53.2	73.3	79.3	70.1	32.8	50.7
50	9/12	347	37.3	22.6	49.0	26.3	15.7	0.0	55.0	64.6	34.8	52.7	55.2	38.2	37.0
	9/13	348	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/14	349	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/15	350	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/16	351	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/17	352	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/18	353	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
51	9/19	354	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/20	355	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/21	356	38.4	30.2	43.1	43.7	27.1	0.0	35.2	47.7	49.9	22.9	39.5	27.6	35.3
	9/22	357	42.9	27.4	34.0	21.4	31.5	0.0	36.3	42.0	55.3	33.9	21.6	26.0	32.0
	9/23	358	63.0	44.8	50.3	27.0	24.2	0.0	28.4	34.2	35.2	33.4	36.2	25.3	34.3
	9/24	359	46.3	26.2	42.1	36.3	20.2	0.0	28.6	25.8	37.9	24.5	18.7	25.3	29.6
	9/25	360	48.1	34.8	24.1	40.4	43.0	0.0	57.7	54.1	52.6	60.7	65.4	29.7	40.3
52	9/26	361	39.3	37.2	37.5	50.3	17.3	0.0	48.6	38.3	41.3	36.6	28.5	21.9	34.1
	9/27	362	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	9/28	363	63.5	42.9	57.4	19.0	26.2	0.0	51.6	31.3	28.4	68.5	22.2	35.5	37.3
	9/29	364	62.1	20.9	39.2	20.4	15.1	0.0	40.8	45.9	62.6	97.9	40.5	38.0	38.5
	9/30	365	70.8	23.3	42.1	12.8	38.6	0.0	44.1	24.7	44.0	39.8	27.4	49.2	35.6
	10/ 1	366	65.4	46.8	44.4	31.5	39.7	0.0	35.2	42.1	25.5	67.8	31.7	16.8	35.8
	10/ 2	367	78.0	59.2	54.9	65.0	25.6	9.8	61.7	27.2	36.9	53.0	81.1	23.7	46.9
53	10/ 3	368	79.1	64.5	41.6	23.4	29.8	0.0	109.7	60.7	39.4	125.5	44.7	28.6	49.9
	10/ 4	369	36.4	42.4	35.7	21.3	28.3	0.0	22.3	36.1	27.1	29.3	34.1	29.8	29.0
	10/ 5	370	22.2	36.7	38.3	15.4	21.8	0.0	76.3	31.1	58.0	49.0	62.3	31.2	35.9
	10/ 6	371	32.3	11.6	62.0	17.9	34.4	0.0	49.0	38.5	27.1	87.7	27.1	28.6	33.1
	10/ 7	372	36.7	17.0	24.1	22.0	25.7	0.0	25.4	31.4	39.8	43.3	47.4	27.1	27.1
	10/ 8	373	60.3	29.0	33.6	17.0	42.0	0.0	84.8	29.2	39.5	37.5	43.1	38.3	37.3
	10/ 9	374	63.5	40.6	39.5	27.0	34.0	0.0	77.8	53.1	81.3	71.9	53.1	27.2	46.2
54	10/10	375	74.3	22.6	41.1	70.1	29.0	0.0	107.4	39.3	34.2	79.8	45.3	26.1	45.9
	10/11	376	39.5	76.5	61.0	59.7	50.7	0.0	47.5	55.9	30.3	116.2	79.6	22.4	49.4
	10/12	377	100.3	46.3	28.7	17.6	31.6	0.0	44.9	39.8	44.0	43.4	23.7	32.0	37.2
	10/13	378	36.6	23.8	47.7	15.9	66.9	0.0	43.6	36.6	30.5	62.5	21.4	34.2	34.2
	10/14	379	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10/15	380	92.6	42.5	30.6	19.5	18.6	0.0	36.7	26.4	37.7	40.9	82.6	38.0	37.0
	10/16	381	51.3	26.6	32.8	39.7	121.7	0.0	78.5	16.4	62.5	77.0	64.7	19.1	45.1
55	10/17	382	47.8	65.8	55.4	54.1	48.1	0.0	111.8	38.6	34.3	32.0	62.3	18.1	47.2
	10/18	383	49.5	72.3	29.9	19.6	23.0	0.0	68.7	35.0	24.8	58.9	40.6	27.0	36.1
	10/19	384	53.9	38.7	42.3	20.2	40.5	0.0	30.4	41.3	19.8	36.7	18.0	39.8	32.7
	10/20	385	64.4	11.3	50.1	16.5	17.8	0.0	41.4	29.9	16.2	42.9	18.8	31.6	28.9
	10/21	386	49.6	10.6	31.5	22.6	31.8	0.0	26.4	26.3	31.1	34.2	37.9	25.6	26.9
	10/22	387	60.1	40.3	34.5	43.5	86.9	0.0	86.0	26.5	44.3	107.9	18.8	29.8	45.5
	10/23	388	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
56	10/24	389	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10/25	390	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	10/26	391	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

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10/27	392	112.4	22.8	20.1	14.2	28.5	0.0	39.3	27.3	29.7	43.9	29.6	42.0	33.4
10/28	393	80.8	44.4	0.0	19.8	19.9	0.0	25.5	51.9	41.8	69.7	44.6	38.0	33.8
10/29	394	28.6	30.1	0.0	23.8	23.1	0.0	48.4	34.2	26.9	46.8	25.8	31.0	25.3
10/30	395	52.8	56.7	0.0	35.1	31.3	0.0	72.0	81.5	29.1	120.8	83.9	29.3	42.4
10/31	396	66.4	34.7	0.0	52.1	38.6	0.0	55.4	62.0	37.8	145.8	47.1	29.2	41.3
11/ 1	397	44.6	30.1	0.0	19.0	62.2	0.0	34.4	34.2	17.6	69.7	26.6	38.5	28.4
11/ 2	398	50.0	67.3	0.0	20.0	90.1	0.0	48.4	49.6	59.7	55.8	44.2	41.6	41.6
11/ 3	399	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

WEEKLY 15 MINUTE PEAK WATER FLOW

WEEK NO.	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5	NIT 6	UNIT 7	UNIT 8	UNIT 9	UNIT 10	UNIT 11	UNIT 12	TOTAL UNITS
1	41.5	98.7	37.9	42.1	47.2	0.0	51.2	45.9	61.7	91.8	22.6	15.0	147.5
2	41.6	59.9	98.8	36.0	44.4	0.0	43.3	66.8	49.2	34.8	44.8	4.5	175.6
3	59.0	82.2	46.8	36.4	55.1	0.0	63.9	64.6	52.9	47.9	22.7	7.4	249.6
4	45.0	43.4	31.9	42.2	87.5	0.0	27.6	45.1	60.7	36.0	18.2	0.0	333.7
5	94.5	50.0	59.9	31.4	87.2	0.0	70.5	49.1	96.6	61.6	24.6	15.4	270.3
6	64.0	46.9	93.7	34.0	60.6	0.0	52.6	51.7	70.8	47.3	41.3	4.3	300.9
7	80.4	42.5	30.8	53.4	52.1	4.7	87.8	39.0	60.1	96.6	29.1	27.1	332.3
8	75.6	52.2	95.9	25.2	82.1	0.0	50.2	54.2	79.4	62.4	36.8	5.9	212.8
9	32.5	49.6	59.9	42.2	57.3	54.7	41.6	41.5	60.7	61.5	44.1	22.4	127.6
10	45.0	32.3	50.7	30.1	48.2	55.4	40.4	45.5	56.8	38.5	39.7	58.0	119.6
11	60.8	56.8	46.7	42.9	52.6	48.9	40.4	56.4	46.3	47.6	26.8	60.9	142.6
12	55.0	43.5	97.5	37.8	60.9	34.5	32.5	57.2	63.4	50.7	27.8	32.8	187.0
13	50.1	42.9	44.4	37.2	45.3	45.6	49.1	68.7	62.9	38.4	29.7	73.2	152.7
14	98.4	96.7	44.0	32.0	44.3	41.1	41.4	35.5	98.0	36.9	29.4	70.2	184.4
15	48.6	36.8	98.6	22.1	62.9	67.2	94.8	70.7	34.6	40.4	57.2	47.4	166.6
16	39.8	36.8	42.1	30.1	39.9	41.5	38.5	29.3	88.2	84.0	49.6	27.1	198.8
17	98.6	35.7	58.2	27.8	86.4	33.0	31.8	45.4	97.7	44.5	36.9	54.4	170.2
18	98.8	60.6	33.4	90.4	37.5	47.8	49.4	33.4	39.9	72.3	27.4	34.6	144.5
19	39.0	49.8	57.7	18.2	47.1	59.8	52.0	41.5	96.9	98.0	88.3	45.7	182.5
20	64.9	44.3	29.7	33.4	46.5	60.6	34.6	41.4	68.7	90.3	20.9	34.1	165.9
21	40.8	47.2	45.4	37.9	63.5	52.3	27.6	64.7	97.1	60.4	23.3	31.9	164.3
22	98.2	45.7	48.1	98.3	57.1	52.5	44.5	60.7	48.7	39.4	27.9	55.0	393.0
23	76.9	95.5	49.0	94.9	52.9	54.7	33.0	36.4	66.9	95.5	74.6	73.8	589.2
24	40.0	46.2	38.1	37.6	98.2	97.7	35.2	71.8	97.3	42.3	22.9	27.7	219.0
25	60.1	38.6	69.5	38.8	42.9	89.8	41.4	89.1	41.9	32.3	25.9	48.7	291.0
26	30.3	46.8	98.6	24.6	48.7	40.1	42.3	28.1	41.0	39.7	28.0	52.3	125.8
27	77.3	50.9	31.0	27.4	74.2	72.5	39.2	37.4	97.9	32.3	25.7	73.2	155.4
28	39.3	89.9	47.1	62.9	43.1	60.1	76.3	44.2	61.8	45.7	34.8	46.5	450.3
29	38.4	36.4	87.1	30.5	57.3	41.4	50.5	45.0	47.3	32.9	24.3	66.8	490.7
30	52.5	36.6	97.2	25.0	34.1	22.4	29.9	47.1	49.6	33.2	33.7	37.5	149.3
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	21.6	98.7	38.2	16.7	18.0	36.8	31.7	24.7	37.4	19.1	15.9	43.9	170.2
33	51.2	98.3	58.5	33.3	20.6	15.1	33.6	49.2	97.9	53.5	52.3	95.9	554.4
34	38.9	66.6	64.0	34.0	31.5	0.0	26.1	45.2	64.0	33.3	27.5	34.4	172.0
35	32.1	55.6	40.3	55.7	20.3	0.0	38.7	35.0	37.8	30.9	88.5	29.2	341.3
36	34.3	98.5	62.9	46.2	35.3	5.2	48.6	57.2	94.0	35.2	70.5	88.6	610.9
37	35.0	97.4	42.4	44.4	51.2	23.7	26.6	70.7	98.6	58.1	22.9	70.2	200.7
38	98.6	44.2	47.9	55.4	57.1	0.0	46.1	40.1	41.5	58.1	29.1	59.3	159.0
39	39.3	69.2	92.7	37.4	50.5	5.2	47.4	52.5	95.0	60.6	22.3	96.0	187.1
40	39.2	46.6	45.5	3.8	57.8	20.3	47.6	49.4	61.8	50.8	50.9	65.5	221.6
41	47.6	45.4	85.0	45.5	85.5	0.0	36.8	44.7	79.3	51.6	28.8	63.3	192.4
42	60.8	48.6	41.4	28.4	97.8	0.0	42.0	47.9	95.9	37.3	28.4	50.4	149.4
43	86.6	65.4	73.7	45.0	60.3	0.0	54.3	53.3	66.2	43.0	26.2	66.7	330.8
44	26.4	52.6	54.3	40.1	49.5	0.0	43.0	44.5	55.3	40.8	33.7	91.4	241.7
45	28.4	91.8	40.8	63.9	61.1	0.0	46.0	56.3	71.5	40.2	52.5	54.2	348.0
46	47.5	68.8	81.7	55.1	74.8	0.0	36.6	71.7	97.1	48.6	42.7	68.9	605.4
47	51.6	57.9	39.8	51.5	50.7	0.0	33.1	62.6	48.6	51.3	49.9	88.7	169.1
48	37.4	63.7	67.4	40.4	42.6	10.7	29.6	83.8	49.1	48.1	50.3	93.5	120.6
49	85.2	44.1	57.4	63.1	39.2	0.0	41.0	40.7	79.0	37.1	35.5	72.0	359.5

50	42.2	94.7	39.6	39.7	37.0	0.0	34.8	39.5	58.8	45.6	33.3	86.9	241.3
51	22.7	36.0	29.0	53.3	26.1	0.0	80.8	27.6	43.2	19.0	19.6	23.1	99.7
52	41.1	56.2	98.6	96.4	39.0	0.0	76.2	54.5	60.4	46.0	35.0	96.7	167.5
53	53.2	56.5	90.8	67.3	70.4	11.1	46.6	63.3	42.1	41.1	45.5	96.5	479.2
54	78.8	45.4	97.3	61.1	55.1	0.0	29.6	44.7	52.2	67.0	35.7	37.6	243.9
55	97.5	62.2	66.9	48.2	50.2	0.0	57.7	50.9	48.0	47.3	72.4	51.6	344.7
56	51.7	62.3	78.2	50.8	45.2	0.0	26.1	26.9	43.5	37.0	27.6	46.6	154.3
57	34.7	47.8	0.0	61.1	47.3	0.0	38.6	47.9	51.6	97.8	48.8	40.5	268.1

WEEKLY HOURLY PEAK WATER FLOW

WEEK NO.	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6	UNIT 7	UNIT 8	UNIT 9	UNIT 10	UNIT 11	UNIT 12	TOTAL UNITS
1	66.2	104.1	52.0	42.1	52.3	0.0	63.5	68.4	69.4	98.8	40.3	15.2	240.5
2	67.4	63.7	103.6	39.5	60.7	0.0	57.6	74.1	63.8	65.7	73.1	4.5	236.7
3	112.1	137.1	78.5	48.7	61.0	0.0	85.4	75.9	85.6	63.4	28.7	8.6	286.9
4	77.4	61.8	55.9	62.2	105.6	0.0	50.0	56.7	84.6	58.4	36.1	0.0	387.4
5	120.2	64.0	61.7	39.2	105.4	0.0	109.8	52.5	191.7	95.7	42.1	16.1	333.0
6	87.0	56.2	110.5	43.0	65.5	0.0	73.3	55.0	103.1	89.1	54.4	4.3	375.5
7	83.6	65.5	51.9	53.4	59.9	4.8	109.9	56.0	75.2	113.1	45.3	27.1	339.8
8	79.6	66.8	107.2	34.9	105.6	0.0	56.8	54.5	92.3	67.2	49.6	5.9	258.3
9	51.8	70.2	80.5	46.8	61.1	97.5	81.1	52.9	66.4	65.1	52.0	22.3	202.7
10	53.4	51.4	77.9	36.0	63.9	76.3	50.2	46.7	93.2	53.0	44.9	73.5	194.2
11	76.4	64.3	55.4	44.7	52.9	58.1	67.2	70.7	58.5	71.8	43.7	67.7	213.7
12	65.9	58.4	118.9	44.4	66.4	59.4	44.2	64.4	75.9	55.9	37.5	50.9	249.9
13	62.1	69.0	99.3	49.3	54.5	59.4	63.2	69.2	83.0	62.6	39.7	82.5	255.2
14	108.1	104.9	69.8	60.2	50.4	52.6	66.0	46.0	124.5	53.3	54.5	74.6	292.2
15	65.1	55.7	107.2	30.2	80.0	67.5	102.6	84.2	58.5	66.6	84.1	78.9	284.7
16	59.2	66.7	63.3	38.3	59.2	54.4	66.7	43.1	115.3	99.6	51.4	41.4	292.7
17	105.7	61.2	105.7	37.0	105.5	43.5	48.3	68.4	106.1	50.7	45.9	76.5	246.9
18	98.8	98.5	52.4	104.8	55.4	65.3	76.9	55.6	58.5	80.3	39.6	57.4	239.3
19	50.1	72.7	92.1	21.7	66.7	69.9	66.5	57.1	123.2	119.1	107.1	75.7	278.4
20	71.8	71.2	43.7	35.4	65.6	74.4	56.0	63.1	118.7	100.5	41.4	34.1	215.3
21	59.2	89.1	69.3	42.0	77.2	64.5	53.3	100.1	111.7	75.5	42.6	41.7	254.5
22	102.7	61.9	61.0	168.0	70.1	92.8	74.1	60.7	68.9	46.9	47.4	66.6	449.6
23	70.9	95.5	54.3	94.9	89.6	75.7	53.6	60.4	66.9	104.0	74.6	73.8	589.2
24	56.3	74.3	60.5	40.0	100.0	107.6	53.6	119.5	104.1	50.4	45.3	39.4	310.2
25	76.8	67.2	91.7	54.7	69.7	89.8	70.4	109.3	60.3	49.5	46.5	58.1	329.9
26	49.3	54.7	105.9	37.7	53.2	53.5	66.5	49.5	63.4	56.7	44.5	61.1	193.2
27	77.3	92.0	53.3	37.3	82.1	75.7	71.2	68.3	105.9	46.4	48.1	73.2	219.9
28	52.5	91.0	69.6	67.5	59.7	77.0	90.2	80.1	77.4	47.8	47.9	51.3	494.4
29	53.8	56.0	91.8	35.0	81.9	58.2	50.5	53.9	61.2	46.3	46.9	84.1	530.0
30	56.3	51.1	108.5	34.4	50.6	31.7	50.1	67.5	58.5	58.3	45.4	72.4	242.3
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	22.5	98.8	67.5	18.8	21.0	64.8	40.5	42.5	42.2	29.4	22.1	50.0	182.4
33	56.2	135.8	70.6	35.1	21.8	23.4	39.2	99.3	103.9	53.5	54.7	95.9	592.8
34	43.9	103.3	123.0	47.4	52.4	0.0	51.8	71.5	81.8	54.2	44.4	54.8	213.7
35	35.8	72.8	66.1	72.0	28.4	0.0	44.2	39.6	61.7	41.6	89.1	39.8	407.2
36	44.8	120.4	73.0	69.5	55.9	5.2	48.6	57.3	98.3	42.2	111.5	94.0	650.5
37	45.1	97.8	63.1	48.5	79.0	40.9	49.4	84.1	187.9	84.2	45.2	76.2	286.1
38	103.0	58.7	68.5	80.5	85.5	0.0	72.8	54.7	63.4	113.5	38.4	83.4	284.5
39	131.8	89.1	119.5	51.0	69.6	5.3	57.8	67.1	139.6	83.8	35.0	117.5	289.1
40	54.7	61.3	69.6	7.2	57.8	30.1	61.5	90.5	87.3	67.2	73.0	85.9	267.0
41	64.9	79.1	117.1	65.6	105.2	0.0	51.4	83.4	131.2	54.7	49.8	98.0	242.2
42	66.3	63.7	55.1	36.5	106.2	0.0	61.7	89.0	119.6	56.2	46.7	68.8	229.3
43	110.7	99.2	73.7	49.0	67.3	0.0	54.3	55.7	82.6	54.9	43.2	92.3	330.8
44	37.5	81.3	59.3	51.6	49.6	0.0	53.7	64.7	72.9	46.2	45.0	108.2	266.6
45	51.8	145.5	54.8	106.8	81.1	0.0	84.0	71.4	80.5	59.4	52.6	57.1	389.4
46	68.9	83.7	90.7	56.4	80.2	0.0	60.1	78.8	102.7	73.1	43.2	78.1	653.0
47	52.5	81.7	56.9	65.9	71.8	0.0	50.0	63.2	76.0	67.6	82.8	175.2	261.6
48	37.4	80.0	133.4	65.5	69.0	11.8	55.0	106.7	64.8	67.6	82.1	60.9	226.1
49	105.7	46.7	70.0	63.2	48.3	0.0	71.7	76.7	91.6	66.3	42.3	99.8	408.0

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 50     53.1   141.1    68.1    73.2    55.9     0.0    64.5    53.1    93.8    68.0    42.4    86.9   324.5
 51     37.8    43.3    33.3    76.3    27.0     0.0   105.5    46.7    65.6    35.4    35.8    32.8   181.2
 52     48.5    65.9   112.9   103.3    42.3     0.0    82.6    54.6    71.8    65.0    45.7   106.8   273.1
 53     55.6    79.7    94.8    87.3    78.8    17.6    68.6    63.3    71.3    50.3    68.0   102.5   489.2
 54    121.6    90.8   109.8    73.7    73.6     0.0    51.9    61.0    73.9    80.9    43.7    42.1   294.1
 55    103.9    93.4    66.9    72.1    86.4     0.0    73.2    69.3    81.1    57.1    76.2    56.3   346.7
 56     62.5    85.9    82.2    72.0    49.5     0.0    38.7    51.5    79.5    56.8    44.9    54.3   219.6
 57     39.0    73.8     0.0    65.5    60.2     0.0    55.6    77.5    74.2   194.6    59.4    46.3   284.2
                               MONTHLY 15 MINUTE PEAK WATER FLOW
MONTH   UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    TOTAL

          1       2       3       4       5       6       7       8       9      10      11      12    UNITS

  1     59.0    98.7    98.8    42.2    87.5     0.0    63.9    66.8    63.6    91.8    44.8    15.0   333.7
  2     94.5    52.2    95.9    53.4    87.2     4.7    87.8    54.2    96.6    96.6    44.1    27.1   332.3
  3     98.4    58.8    97.5    42.9    60.9    55.4    49.1    68.7    63.4    50.7    40.4    73.2   187.0
  4     98.6    90.7    98.6    90.4    86.4    62.2    94.8    70.7    98.0    84.0    57.2    70.2   198.8
  5     98.8    60.8    57.7    98.3    63.5    60.6    52.0    84.7    97.1    98.0    88.3    45.7   182.5
  6     70.9    95.5    98.6    94.9    98.2    97.7    44.3    89.1    97.3    95.5    74.6    73.8   589.2
  7     77.3    89.9    97.2    67.9    79.2    72.5    76.3    47.1    97.9    45.7    34.8    73.2   490.7
  8     51.2    98.7    64.6    55.0    31.5    36.8    38.7    89.2    97.9    53.5    88.5    95.9   554.4
  9     98.6    98.5    92.7    55.4    57.1    23.7    48.6    70.7    98.6    60.6    70.5    96.0   610.9
 10     80.6    65.4    85.0    49.0    97.8    20.3    54.3    53.9    95.9    51.6    50.9    91.4   330.8
 11     51.6    91.8    81.7    63.9    74.8    10.7    49.0    71.7    97.3    51.3    52.6    88.7   605.4
 12     85.2    94.7    98.6    96.4    39.2     0.0    80.8    63.8    79.0    46.0    90.3    96.7   399.5
 13     97.5    62.3    97.3    87.3    70.4    11.1    57.7    63.3    52.2    97.8    72.4    58.6   479.2
 14     34.7    37.9     0.0    56.2    47.3     0.0    38.6    47.9    51.6    31.9    19.6    37.4   268.1


                               MONTHLY HOURLY PEAK WATER FLOW
MONTH   UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    TOTAL

          1       2       3       4       5       6       7       8       9      10      11      12    UNITS

  1    112.1   137.1   103.6    62.2   105.6     0.0    85.4    75.9    85.6    98.8    73.1    15.2   387.4
  2    120.2    70.2   110.5    53.4   105.6     4.8   109.9    56.0   191.7   113.1    54.4    27.1   375.5
  3    106.1    69.0   114.9    54.3    66.4    97.5    67.2    70.7    93.2    71.8    54.5    82.5   292.2
  4    105.7   104.9   107.2   104.8   105.5    67.5   102.6    84.2   124.5    99.6    84.1    78.9   292.7
  5    102.7    98.5    92.1   168.0    77.2    92.8    74.1   100.1   173.2   119.1   107.1    75.7   278.4
  6     70.8    95.5   105.9    94.9   100.0   107.6    70.4   119.5   104.1   104.0    74.6    73.8   589.2
  7     77.3    92.0   108.5    67.5    82.1    77.0    90.2    80.1   105.9    58.3    48.1    84.1   530.0
  8     56.2   135.8   123.0    72.0    52.4    64.8    51.8    99.3   103.9    54.2    89.1    95.9   592.8
  9    131.8   120.4   114.5    80.5    85.5    40.9    72.8    84.1   187.9   113.5   111.5   117.5   650.5
 10    110.7    99.2   117.1    65.6   106.2    30.1    61.7    90.5   131.2    67.2    73.0   108.2   330.8
 11     68.9   145.5   133.4   106.8    81.1    11.8    84.0    78.8   102.7    73.1    82.8   175.2   653.0
 12    105.7   141.1   112.9   103.3    55.9     0.0   105.5   106.7    93.8    68.0    82.1   106.8   408.0
 13    121.6    93.4   109.8    87.3    96.4    17.6    73.2    77.5    81.1   194.6    76.2    58.6   489.2
 14     34.7    46.6     0.0    56.2    60.2     0.0    38.6    52.8    74.2    36.4    25.3    46.3   268.1
                               TOTAL WATER FLOW PER WEEK
WEEK    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    TOTAL

NO.       1       2       3       4       5       6       7       8       9      10      11      12    UNITS

  1   2465.6  1509.9  2157.4  1195.4  1394.5     0.0  1650.9  1746.2  2132.1  1254.2   745.5    25.1 16246.8
  2   3123.8  2265.4  2235.3  1286.2  1648.2     0.0  1637.3  2291.6  1951.4  1161.0   843.5     9.9 18474.5
  3   5149.1  2256.8  1875.6   949.6  1927.2     0.0  1407.1  2187.8  2251.8  1020.1   748.4     8.6 19982.0
  4   5881.6  1676.2  2148.2  1137.9  2054.1     0.0  1051.1   305.0  2565.1  1138.6   688.8     0.0 18647.0
  5   6917.5  2206.4  2338.5  1087.4  1556.5     0.0  1490.6  1585.8  2109.7  1221.9   764.7    29.7 21221.1
  6   7097.2  2014.6  2258.3  1089.8  1342.8     0.0  1568.5  1696.6  2144.4   914.2   774.9     4.3 20955.3
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   7      2540.8   1573.2   1820.4   1232.4   1900.0      4.8   1054.4   1575.6   1760.9   1095.5    772.8     27.2 15370.0
   8      1221.6   1143.6   1852.1    952.7   1397.8      6.0   1615.1   2056.6   2217.1   1232.8    757.9     25.8 14675.1
   9      1077.0   2065.8   2133.7   1243.4   2053.5    196.9   1475.0   1716.0   2459.7   1215.9   1013.7     69.8 16759.8
  10      1201.8   1256.5   2311.0   1097.8   1740.3   1290.3   1017.9   1679.3   1901.5   1019.8    643.9   1661.8 16919.9
  11      1185.5   1737.5   2429.5   1025.8   1588.2   1737.9    891.1   1415.1   1799.6   1024.3    741.6   2318.9 17867.0
  12      1208.7   2035.0   2566.4   1050.0   2133.2   1778.0   1025.5   1582.4   2032.2   1115.5    799.5   1992.0 19422.5
  13      1613.6   2347.0   2284.0   1143.6   1475.3   1937.2   1837.3   1677.9   2220.2   1318.6    701.2   2578.4 21129.3
  14      1357.4   2451.3   2230.9   1227.8   1770.3   1753.6   1432.4   1924.5   2495.5    958.8   1034.8   1925.2 20566.5
  15      1385.5   1624.3   2277.9   1038.8   2180.4   1689.6   1521.7   1728.4   1855.4    975.8   1193.2   1908.1 19353.5
  16      1335.3   2244.8   2311.4   1094.4   1344.6   1412.4   1156.2   1480.5   2096.4   1096.1   1151.3   2148.5 18871.9
  17      1423.0   1645.1   2292.0   1115.5   1537.4   1394.3   1242.5   1488.5   2178.1   1755.6    684.6   1986.9 19003.3
  18      1356.0   2104.0   2225.3   1275.4   1227.6   1754.4   1659.2   1684.2   1802.5   1877.6    839.8   2131.9 19923.2
  19      1248.9   1927.4   2772.2    805.3   1543.6   1530.7   1245.4   1433.7   2316.7   2247.9    870.3   2185.2 19869.3
  20      1677.5   2108.0   1924.9   1028.7   1568.0   2085.0   1280.5   1852.6   2200.3   1661.7    698.7   1938.4 20003.1
  21      1292.9   2168.2   2253.4   1047.0   1268.4   2385.8    951.1   1647.7   2015.4   1640.6    754.8   1964.7 19392.0
  22      1366.4   1621.0   2349.4   1639.0   1543.4   2232.7   1365.5   1494.3   1650.7   1218.8    698.1   2230.1 19360.4
  23      1252.7   1863.6   2438.8   1261.7   1453.7   1768.0   1058.7   1473.8   1654.1   1397.7    994.9   2485.1 19173.6
  24      1976.5   1927.0   2578.3   1157.8   1159.1   2302.1   1155.5   1492.8   1632.8   1196.5    797.7   1997.0 19583.1
  25       913.6   1523.0   1670.7   1099.2   1529.9   1471.4    990.6   1236.9   1263.4    776.4    551.5   1570.6 14597.2
  26       953.2   1512.8   2207.8   1124.0   1083.8   1759.7   1042.1   1162.7   1819.8   1082.9    789.3   1618.1 16196.1
  27      1225.5   2023.3   2417.5   1415.7   1681.3   1931.4   1314.0   1525.4   1719.5   1064.4    737.5   1888.3 18967.8
  28      1458.3   2001.8   2511.4   1756.5   1609.3   2175.0   1540.8   1253.4   1955.1    952.6   1031.6   2189.1 20435.5
  29      1754.0   1913.0   2667.1   1364.5   1329.5   1109.3   1152.0   1544.5   2096.8   1058.1    646.1   2351.2 19090.7
  30       836.1    565.0    952.4    522.2    775.6    454.7    516.8    643.1    989.7    401.5    425.5   1026.0  8212.6
  31         0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0     0.0
  32       277.5    248.3    388.1    143.3    113.6    443.7    134.7    229.7    198.2     81.1    110.7    347.6  2718.5
  33      1030.3   1748.9   1149.1    710.6    113.4     76.8    554.1    922.0   1784.1    687.0    657.2   1659.4 11095.7
  34      2574.6   3276.8   2501.6   1232.7    213.9      0.0   1188.3   1682.0   2712.8   1150.1   1136.9   2257.6 20126.9
  35      1145.7   1203.2   1055.2    894.0    161.2      0.0    713.1    497.7    907.4    429.9    366.7   1050.3  8424.5
  36      1292.1    868.3   1081.0    623.1    901.5      8.2    378.4    694.2    951.1    350.8    378.3   1291.5  8803.2
  37      2744.6   2207.4   2377.9   1562.9   1888.5     55.4   1461.2   1513.3   3232.3   1289.2    705.9   2736.2 21774.8
  38      2932.7   2266.5   2763.9   1549.2   1881.2      0.0   1772.8   1537.0   1884.2   1591.9   1038.1   2742.6 21734.1
  39      2511.5   2035.6   2379.4    534.9   1567.4     10.2   1693.9   1733.8   3096.7   1306.4    796.8   3096.8 21748.2
  40      1459.5   1905.8   2216.0     18.0   1544.6     54.2   1197.8   1772.3   2109.6   1492.0    952.0   3235.9 18035.6
  41      1876.2   2030.0   2182.7   1208.9    975.9      0.0   1382.2   1965.4   2518.2   1016.7    789.5   2972.5 18918.4
  42      2005.5   1941.2   2068.9   1502.3    958.5      0.0   1770.0   2605.8   2445.3   1096.2   1291.1   2496.9 20181.7
  43      2395.5   2225.3   2400.4   1311.2   1422.7      0.0   1915.8   2101.1   2141.1   1040.1    831.5   2416.3 20200.9
  44      2162.4   2024.6   2171.4   1014.1   1018.6      0.0   1774.9    596.4   1788.2   1023.6    752.6   2215.1 16542.7
  45      2353.9   2471.8   2303.8   2043.0   2120.4      0.0   1344.3   2122.0   2214.9   1336.7    799.1   2287.3 22097.0
  46      3201.6   1485.9   2874.2   1745.7    783.5      0.0   1425.3   1607.7   1878.0   1594.5    855.0   2317.0 19968.5
  47      2019.9   1676.3   2216.8   2038.0    964.9      0.0   1466.5   1576.5   1930.4    937.3    745.2   3338.0 18909.6
  48      1718.9   1326.8   2569.5   1966.3   1433.2     23.9   1596.6   2075.5   2604.6   1456.2    943.7   2632.9 20348.1
  49      1419.5   1416.0   2288.7   1757.2   1005.0      0.0   2671.4   2264.8   2701.0   1481.5    919.5   2993.2 20917.8
  50      1094.1   2626.4   1624.3    762.4    695.3      0.0    999.7   1151.8   1549.0    817.3    605.0   1477.3 13404.6
  51       488.2    402.9    694.1    520.6    293.2      0.0    429.2    538.5    841.8    170.5    183.1    481.9  5043.8
  52      1934.0   1447.1   2256.4   1547.7    729.4      0.0   1534.8   1366.0   2063.9    964.9    634.4   1580.7 16059.1
  53      2306.1   1991.4   2871.1   1498.9   1091.1     49.0   2389.6   1550.6   2064.8   1356.1    924.8   1872.4 19965.9
  54      2467.1   1748.4   2480.5   1835.0   1403.0      0.0   2588.1   1711.6   2396.8   1364.1    940.7   1865.5 20797.8
  55      2157.2   1800.5   2170.8   1356.9   1349.7      0.0   2205.0   1126.0   1563.3    865.5    860.7   1561.5 17017.1
  56      1332.8    516.1    776.0    642.3    735.7      0.0    909.8    480.3    841.3    558.0    259.1    884.8  7935.9
  57      1939.4   1843.4      0.0   1358.1   1326.1      0.0   1705.6   1880.6   1704.0   1525.8    816.3   1868.7 15967.9
                                       TOTAL WATER FLOW PER MONTH
MONTH       UNIT     UNIT     UNIT     UNIT     UNIT     UNIT     UNIT     UNIT     UNIT     UNIT     UNIT     UNIT   TOTAL

               1        2        3        4        5        6        7        8        9       10       11       12   UNITS

   1     19449.8   8776.5   9290.2   5008.3   7359.3      0.0   6109.8   6858.5   9642.4   5208.5   3302.8     43.6 81250.8
   2     15806.5   7539.0   8973.3   4772.1   7589.0      4.8   6688.8   7644.9   9492.4   4860.1   3580.0    125.0 77163.4
   3      5885.5   8263.4  10419.3   4872.9   7534.7   7243.4   5275.5   7192.1   8835.5   4943.8   3424.7   8813.7 82676.4
   4      6046.8   8893.6  10327.3   5140.5   7589.6   6794.3   6406.4   7286.7   9362.2   5553.0   4284.9   9051.3 86730.4
   5      5414.9   8258.3   9156.6   4634.6   5842.6   8177.8   4722.8   6498.5   8055.4   7297.2   3069.3   8086.5 79214.4
   6      5572.2   7455.4   9832.7   4975.8   5776.7   8248.9   4770.0   6114.2   6838.9   4756.1   3393.7   8721.2 76527.2
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7	5276.4	6507.7	8548.4	5062.9	5395.7	5670.4	4523.6	5066.4	6761.1	3476.6	2840.7	7454.6	66686.5
8	5028.1	6477.2	5094.0	2980.3	606.1	520.5	2790.2	3331.4	5602.5	2348.1	2271.5	5314.9	42365.6
9	9480.9	7371.5	8582.2	4275.1	6018.6	73.8	5306.3	5478.3	9164.3	4538.3	2919.1	9867.1	74060.2
10	8614.3	8876.9	9718.8	4471.9	5214.6	54.2	7206.9	8563.4	10008.7	5174.0	4214.4	12084.1	84302.8
11	10993.7	8084.8	11010.6	8199.8	5875.3	23.9	6483.4	7760.9	9164.8	5473.8	3547.5	11268.9	87986.6
12	5546.1	6163.2	7516.5	4664.2	3048.1	0.0	6082.7	5767.8	7964.9	3899.0	2621.9	7535.0	61009.0
13	9210.1	7055.4	7919.7	6276.8	4948.4	49.0	9036.7	6097.5	7599.5	5173.7	3507.3	6888.7	73762.1
14	567.8	661.6	0.0	311.9	761.4	0.0	496.9	503.3	618.3	376.5	212.2	721.2	5251.1

TOTAL WEEKLY FLOW PER CAPITA PER UNIT

WEEK NO.	UNIT 1	UNIT 2	UNIT 3	UNIT 4	UNIT 5	UNIT 6	UNIT 7	UNIT 8	UNIT 9	UNIT 10	UNIT 11	UNIT 12	TOTAL UNITS
1	407.6	215.7	239.7	148.2	278.9	0.0	275.1	291.0	266.5	418.1	248.5	2.8	216.6
2	520.6	326.5	248.4	160.8	329.6	0.0	272.9	381.9	243.9	387.0	281.2	1.1	246.3
3	858.2	322.4	208.4	118.7	385.4	0.0	234.5	364.6	281.5	340.0	249.5	1.0	266.4
4	980.3	239.5	238.7	142.2	413.8	0.0	175.2	50.8	320.6	379.5	229.6	0.0	248.6
5	1152.9	315.5	259.6	135.9	311.2	0.0	233.4	264.3	263.7	407.3	254.9	3.3	282.9
6	1182.9	287.8	250.9	136.2	278.6	0.0	261.4	282.8	268.0	304.7	258.3	0.5	279.4
7	423.5	224.7	202.9	154.0	381.2	1.0	175.7	262.6	220.1	365.2	257.6	3.0	204.9
8	203.6	163.4	205.8	119.1	280.0	0.0	302.5	342.8	277.1	410.9	252.6	2.9	195.7
9	179.5	245.7	237.1	155.4	417.8	39.4	245.8	286.0	307.5	405.3	337.9	7.8	223.5
10	210.3	179.2	256.8	137.2	356.1	258.1	169.6	279.9	237.7	339.9	214.6	184.6	225.6
11	197.6	243.9	269.9	129.2	317.6	347.6	148.5	235.8	224.9	341.4	247.2	257.7	238.2
12	218.1	241.3	285.2	131.2	426.6	355.6	170.9	263.7	254.0	371.8	266.5	221.3	259.0
13	268.9	335.3	253.8	142.9	295.1	387.4	306.2	278.8	277.5	439.5	233.7	286.5	281.7
14	226.2	350.2	247.9	153.5	354.1	350.7	238.7	321.4	311.9	319.6	344.9	213.9	274.2
15	230.1	229.2	253.1	129.6	436.1	337.8	253.6	288.1	231.9	325.3	397.7	212.0	258.0
16	222.5	320.7	254.8	136.8	268.9	282.5	192.7	246.7	262.0	365.4	383.8	238.7	251.6
17	237.2	263.6	254.7	139.4	319.4	278.9	207.1	248.1	272.3	585.2	228.2	220.8	253.4
18	226.0	306.6	247.3	159.4	245.6	351.9	276.5	277.4	225.3	625.9	279.9	236.9	265.6
19	208.1	275.3	308.0	100.0	318.2	306.1	207.6	238.9	252.1	749.3	290.1	242.8	264.9
20	279.6	301.0	213.9	128.6	313.6	413.0	213.4	308.8	275.0	553.9	232.9	215.4	266.7
21	215.5	305.7	250.4	131.1	253.7	477.2	158.5	274.6	251.9	546.9	251.6	218.3	258.6
22	177.7	260.2	266.6	204.9	308.6	446.5	227.6	249.0	206.3	406.3	232.7	247.8	258.1
23	208.8	266.2	271.0	157.7	290.6	353.6	176.4	245.6	206.8	465.9	331.6	276.1	255.6
24	329.4	275.3	266.5	146.0	231.8	460.4	192.6	282.1	204.1	398.8	265.9	221.9	261.1
25	152.3	217.6	165.6	137.4	306.0	294.3	165.1	206.1	157.9	258.8	183.8	174.5	194.6
26	158.9	216.1	245.3	140.5	216.8	351.9	180.3	193.8	227.5	360.9	263.1	179.8	215.9
27	204.9	284.0	268.6	177.0	336.3	386.3	219.0	254.2	214.9	354.8	245.8	209.8	252.6
28	243.1	282.0	279.6	219.6	321.9	435.0	256.8	238.9	244.4	317.5	343.9	243.2	272.5
29	292.3	273.4	296.3	171.1	265.9	221.9	192.0	274.1	262.1	352.7	215.4	261.2	254.5
30	139.3	81.3	105.8	65.3	155.1	90.9	86.1	107.2	123.7	133.8	141.8	114.0	109.5
31	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	46.3	35.5	43.1	17.9	23.1	66.7	22.4	38.3	24.8	27.0	36.9	38.6	36.2
33	171.7	249.3	127.7	88.6	23.1	15.4	92.3	153.7	223.0	229.0	219.1	184.4	147.9
34	429.1	468.1	278.0	154.0	42.8	0.0	231.4	280.3	339.1	383.4	379.0	250.8	268.4
35	190.9	171.9	117.2	111.7	32.2	0.0	118.8	82.9	113.4	143.3	122.2	116.7	112.3
36	215.3	124.0	117.9	78.5	180.3	1.6	63.1	115.7	118.9	116.9	126.1	143.5	117.4
37	457.4	315.3	264.2	195.4	377.7	11.1	243.5	252.2	404.0	429.7	235.3	304.0	290.3
38	408.8	322.9	307.1	193.6	332.2	0.0	295.5	256.2	235.5	530.6	346.0	304.7	289.8
39	418.6	298.8	264.4	66.9	313.5	2.0	282.3	289.0	387.1	435.5	265.6	344.1	290.0
40	243.2	263.7	246.2	7.0	308.9	10.8	199.6	295.4	263.7	497.3	317.3	359.5	240.5
41	312.7	296.0	242.5	151.1	195.2	0.0	230.4	327.6	314.8	338.9	263.2	330.3	252.2
42	334.2	277.3	229.9	187.8	191.7	0.0	295.0	434.3	305.7	365.4	430.4	277.4	269.1
43	399.2	317.9	266.7	163.9	284.5	0.0	319.3	350.2	267.6	346.7	277.2	268.5	269.3
44	360.4	284.2	241.3	126.8	203.7	0.0	295.6	99.4	223.5	341.2	250.9	246.1	220.6
45	492.5	357.1	256.2	255.4	424.1	0.0	274.0	353.7	276.9	445.6	266.4	254.1	294.6
46	533.6	211.3	319.4	219.2	156.7	0.0	237.5	301.2	234.7	531.5	285.0	257.4	266.2
47	336.6	239.5	240.3	254.7	193.0	0.0	244.4	262.7	241.3	312.4	248.4	370.9	252.1
48	288.5	189.5	285.5	245.8	286.6	4.8	206.1	345.9	325.6	485.4	314.6	292.5	271.3
49	236.6	207.3	254.3	219.6	231.0	0.0	445.2	377.5	337.6	493.8	306.5	332.6	278.9

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  50     182.3   375.5   180.5    95.3   139.1     0.0   166.6   192.0   193.6   272.4   201.7   164.1   178.7
  51      81.4    57.6    77.1    65.1    58.6     0.0    71.5    89.7   105.2    56.8    61.0    53.5    67.3
  52     322.3   206.7   250.7   193.5   145.9     0.0   255.8   227.7   258.0   321.6   211.5   175.6   214.1
  53     384.3   284.5   319.0   187.4   218.2     9.8   398.3   258.4   258.1   452.0   308.3   208.0   266.2
  54     411.2   249.8   275.6   229.4   280.0     0.0   431.3   285.3   299.6   454.7   313.6   207.3   277.3
  55     359.5   257.2   241.2   169.6   269.9     0.0   367.5   187.7   195.4   288.5   286.9   173.5   226.9
  56     222.1    73.7    86.2    80.3   147.1     0.0   151.6    80.0   105.2   186.0    86.4    98.3   105.8
  57     323.2   263.3     0.0   169.8   265.2     0.0   284.3   313.4   213.0   508.6   272.1   207.6   212.9
                              TOTAL MONTHLY FLOW PER CAPITA PER UNIT
MONTH     UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT    UNIT   TOTAL

             1       2       3       4       5       6       7       8       9      10      11      12   UNITS

   1    3241.6  1253.8  1032.2   626.0  1471.9     0.0  1018.3  1143.1  1205.3  1736.2  1100.9     4.8  1083.3
   2    2615.7  1077.0   997.0   596.5  1517.8     1.0  1114.8  1307.5  1186.5  1620.0  1193.3    13.9  1028.8
   3     980.9  1180.5  1157.7   609.1  1500.9  1448.7   879.2  1198.7  1104.4  1647.9  1141.6   979.3  1102.4
   4    1006.8  1270.5  1147.5   642.6  1517.9  1358.9  1067.7  1214.4  1170.3  1851.0  1428.3  1005.7  1156.4
   5     902.5  1175.8  1017.4   579.3  1168.5  1635.6   787.1  1083.1  1006.9  2432.4  1023.1   898.5  1056.2
   6     928.7  1065.1  1092.5   622.0  1155.3  1649.8   795.0  1019.0   854.9  1585.4  1131.2   969.0  1020.4
   7     879.7   829.7   949.8   632.9  1079.1  1134.1   753.9   844.4   845.1  1158.9   946.9   828.3   889.2
   8     836.0   925.3   566.0   372.5   121.2   104.1   465.0   555.2   700.3   782.7   757.2   590.5   564.9
   9    1580.1  1053.1   953.6   534.4  1203.7    14.8   684.4   913.0  1145.5  1512.8   973.0  1096.3   987.5
  10    1435.7  1282.4  1079.9   559.0  1042.9    10.8  1201.1  1427.2  1251.1  1724.7  1404.8  1342.7  1124.0
  11    1832.3  1155.0  1223.4  1025.0  1175.1     4.8  1080.6  1293.5  1145.6  1824.6  1182.5  1252.1  1173.2
  12     924.3   880.5   835.2   608.0   609.6     0.0  1013.8   961.3   995.6  1299.7   874.0   837.2   813.5
  13    1535.0  1007.9   880.0   784.6   989.7     9.8  1506.1  1016.2   949.9  1724.6  1169.1   765.4   983.5
  14      94.6    97.4     0.0    39.0   152.3     0.0    82.8    83.9    77.3   125.5    70.7    80.1    70.0
```

APPENDIX F

PRESSURE SEWER SYSTEM DEMONSTRATION PROJECT

CHEMICAL ANALYSIS DATA

COMPOSITE SAMPLES ARE INDICATED BY A 2 IN THE SMTY COLUMN

GRAB SAMPLES ARE INDICATED BY A 1 IN THE SMTY COLUMN

ZERO VALUES SHOWN THROUGHOUT THE FOLLOWING COLUMNS OF DATA AND RESULTS INDICATE THAT NO DATA OR RESULTS ARE AVAILABLE FOR THOSE POINTS

A "LESS THAN" SIGN SHOULD BE PLACED IN FRONT OF ALL VALUES APPEARING IN THE "NO3" AND "SULF" COLUMNS

SAM NUM	DATE	WASTE WATER GPD	SM TY	PH	BOD5 MG/L	TCOD MG/L	SCOD MG/L	TPO4 MG/L	PPO4 MG/L	SPO4 MG/L	ORTO MG/L	NH3 MG/L	ORGN MG/L	NO3 MG/L	NO2 MG/L	STOC MG/L	CL MG/L	SULF MG/L	TURB JTU	ALK MG/L	HARD AS CACO3	GREASE MG/L	MBAS AS LAS MG/L	HG UG/L
1	12/ 2	1566.	1	8.2	222.	1040.	0.	38.0	0.0	0.0	0.0	20.	35.0	0.0	0.0	0.	62.	0.0	0.	0.	62.	0.0	0.32	0.0
2	12/ 3	1567.	1	0.0	0.	0.	0.	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.	0.	0.0	0.	0.	0.	34.0	0.0	0.0
3	12/ 4	1628.	1	8.9	414.	755.	0.	73.0	0.0	0.0	0.0	150.	53.0	0.1	0.0	0.	68.	0.0	0.	0.	66.	0.0	1.40	0.0
4	12/ 9	2230.	1	8.3	276.	725.	0.	39.0	0.0	0.0	0.0	35.	35.3	0.1	0.0	0.	45.	0.0	0.	0.	56.	0.0	2.20	0.0
5	12/10	1957.	1	0.0	0.	0.	0.	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.	0.	0.0	0.	0.	0.	129.5	0.0	0.0
6	12/11	2164.	1	8.0	528.	900.	0.	60.0	0.0	0.0	0.0	45.	71.0	0.1	0.0	0.	76.	0.0	0.	0.	50.	0.0	1.10	0.0
7	12/16	1795.	1	8.7	324.	760.	0.	31.0	0.0	0.0	0.0	160.	62.5	0.0	0.0	0.	74.	0.0	0.	0.	74.	0.0	0.80	0.0
8	12/23	2427.	1	8.1	246.	540.	0.	30.0	0.0	0.0	0.0	41.	47.3	0.1	0.0	0.	49.	0.0	0.	0.	64.	0.0	0.70	0.0
9	12/24	2806.	1	0.0	0.	0.	0.	0.0	0.0	0.0	0.0	0.	0.0	0.0	0.0	0.	0.	0.0	0.	0.	0.	54.0	0.0	0.0
10	12/30	2456.	1	8.4	340.	810.	0.	45.0	0.0	0.0	0.0	80.	69.0	0.0	0.0	0.	105.	0.0	0.	0.	64.	0.0	2.40	0.0
11	12/31	2651.	1	8.8	432.	1500.	0.	43.0	0.0	0.0	0.0	100.	56.0	0.1	0.0	0.	58.	0.0	0.	0.	78.	0.0	32.00	0.0
12	1/ 6	1996.	1	7.7	418.	990.	0.	64.0	0.0	0.0	0.0	60.	22.9	0.1	0.0	0.	79.	0.0	0.	0.	62.	0.0	2.60	0.0
13	1/ 7	1998.	1	7.9	276.	545.	0.	52.0	0.0	0.0	0.0	90.	43.4	0.0	0.0	0.	65.	0.0	0.	0.	66.	29.0	3.90	0.0
14	1/ 8	2294.	1	8.1	330.	900.	0.	30.0	0.0	0.0	0.0	60.	33.0	0.2	0.0	0.	48.	0.0	0.	0.	70.	0.0	32.00	0.0
15	1/13	2061.	1	7.7	156.	390.	0.	85.0	0.0	0.0	0.0	15.	12.6	0.0	0.0	0.	17.	0.0	0.	0.	48.	0.0	8.80	0.0
16	1/14	2264.	1	8.1	330.	800.	0.	55.0	0.0	0.0	0.0	46.	50.5	0.0	0.0	0.	46.	0.0	0.	0.	66.	91.0	6.00	0.0
17	1/15	2024.	1	8.3	372.	770.	0.	38.0	0.0	0.0	0.0	55.	63.0	0.0	0.0	0.	57.	0.0	0.	0.	68.	0.0	7.00	0.0
18	1/20	1869.	1	8.6	264.	475.	0.	32.0	0.0	0.0	0.0	72.	69.0	0.0	0.0	0.	55.	0.0	0.	0.	60.	0.0	1.40	0.0
19	1/21	2046.	1	0.0	240.	475.	0.	34.0	0.0	0.0	0.0	50.	63.0	0.0	0.0	0.	83.	0.0	0.	0.	60.	40.0	2.70	0.0
20	1/22	1883.	1	8.5	222.	545.	0.	50.0	0.0	0.0	0.0	64.	66.0	0.0	0.0	0.	61.	0.0	0.	0.	62.	0.0	3.50	0.0
21	1/27	1856.	1	8.4	228.	420.	0.	40.0	0.0	0.0	0.0	70.	52.0	0.0	0.0	0.	66.	0.0	0.	0.	64.	0.0	4.30	0.0
22	1/28	2337.	1	8.5	234.	730.	0.	32.0	0.0	0.0	0.0	80.	81.0	0.0	0.0	0.	64.	0.0	0.	0.	96.	0.0	41.00	0.0
23	1/29	2494.	1	8.7	324.	790.	0.	42.0	0.0	0.0	0.0	40.	67.0	0.0	0.0	0.	43.	0.0	0.	0.	62.	71.0	3.80	0.0
24	2/ 3	2201.	1	8.1	402.	730.	0.	43.0	0.0	0.0	0.0	50.	59.7	0.0	0.0	0.	56.	0.0	0.	0.	68.	0.0	5.40	0.0
25	2/ 4	2089.	1	7.7	318.	685.	0.	68.0	0.0	0.0	0.0	70.	93.5	0.0	0.0	0.	67.	0.0	0.	0.	66.	33.4	4.20	0.0
26	2/ 5	1880.	1	0.0	552.	1225.	0.	39.0	0.0	0.0	0.0	66.	39.5	0.0	0.0	0.	0.	0.0	0.	0.	68.	0.0	14.20	0.0
27	2/10	1884.	1	8.1	306.	680.	0.	43.0	0.0	0.0	0.0	55.	68.0	0.1	0.0	0.	60.	0.0	0.	0.	66.	0.0	10.60	0.0
28	2/11	1981.	1	8.4	318.	665.	0.	31.0	0.0	0.0	0.0	45.	52.0	0.1	0.0	0.	50.	0.0	0.	0.	64.	50.0	5.50	0.0
29	2/16	2004.	2	7.9	366.	1140.	0.	37.0	0.0	0.0	0.0	68.	11.0	0.1	0.0	0.	56.	0.0	0.	0.	66.	0.0	12.60	0.0
30	2/17	2143.	2	7.6	336.	725.	0.	43.0	0.0	0.0	0.0	60.	38.0	0.1	0.0	0.	51.	0.0	0.	0.	66.	0.0	7.00	0.0
31	2/18	1869.	2	0.0	318.	865.	0.	24.0	0.0	0.0	0.0	58.	19.0	0.0	0.0	0.	0.	0.0	0.	0.	68.	0.0	16.00	0.0
32	2/19	2044.	2	8.1	330.	940.	0.	57.0	0.0	0.0	0.0	68.	0.0	0.1	0.0	0.	0.	0.0	0.	0.	90.	0.0	0.0	0.0
33	2/20	2526.	2	8.2	306.	900.	0.	58.0	0.0	0.0	0.0	64.	66.0	0.0	0.0	0.	0.	0.0	0.	0.	66.	0.0	0.0	0.0
34	2/21	3311.	2	7.6	258.	735.	0.	80.0	0.0	0.0	0.0	56.	7.0	0.1	0.0	0.	49.	0.0	0.	0.	0.	0.0	13.20	0.0
35	2/22	2039.	2	8.0	216.	725.	0.	43.0	0.0	0.0	31.0	56.	33.0	0.1	0.0	0.	54.	0.0	0.	0.	64.	0.0	9.20	0.0
36	2/23	1950.	2	7.6	432.	905.	0.	37.0	0.0	0.0	4.0	40.	34.0	0.1	0.0	0.	58.	0.0	0.	0.	80.	0.0	0.0	0.0
37	2/24	2110.	2	7.6	432.	900.	0.	51.0	0.0	0.0	0.0	50.	32.0	0.1	0.0	0.	49.	0.0	0.	0.	70.	0.0	13.40	0.0
38	2/25	2304.	2	0.0	366.	820.	0.	46.0	0.0	0.0	0.0	60.	32.0	0.1	0.0	0.	56.	0.0	0.	0.	68.	0.0	11.00	0.0
39	2/26	2099.	2	8.0	330.	800.	0.	0.0	0.0	0.0	0.0	56.	12.0	0.0	0.0	0.	0.	0.0	0.	197.	68.	0.0	0.0	0.0
40	2/27	2386.	2	8.1	342.	770.	0.	0.0	0.0	0.0	0.0	58.	17.0	0.0	0.0	0.	0.	0.0	0.	200.	66.	0.0	0.0	0.0
41	2/28	2994.	2	7.6	270.	670.	0.	68.0	0.0	0.0	38.0	42.	27.0	0.1	0.0	0.	47.	0.0	0.	0.	70.	140.0	24.00	0.0

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 42  3/ 1 1956.  2 8.1 348.  920.     0. 42.0  0.0  0.0 30.0   64. 26.0  0.1 0.0     0.  51.  0.0   0.   0.  68.    0.0 10.00 0.0
 43  3/ 2 1983.  2 7.7 348.  915.     0. 34.0  0.0  0.0 23.0   60. 25.0  0.1 0.0     0.  48.  0.0   0.   0.  72.    0.0  9.80 0.0
 44  3/ 3 2083.  2 7.7 324. 1450.     0. 48.0  0.0  0.0 20.0   60. 33.0  0.1 0.0     0.  59.  0.0   0.   0.  72.    0.0 10.50 0.0
 45  3/ 4 2568.  2 7.1 332.  735.     0. 33.4  9.4 24.0 27.0   48. 32.0  0.1 0.0     0.  52.  0.0   0.   0.  72.    0.0 12.00 0.0
 46  3/ 5 2370.  2 8.0 366.  850.     0. 24.6  8.6 16.0  0.0   56. 17.0  0.0 0.0     0.   0.  0.0   0.   0.  64.    0.0  0.0  0.0
 47  3/ 6 3152.  2 8.5 345. 1095.     0.  0.0  0.0  0.0  0.0   56. 13.0  0.0 0.0     0.   0.  0.0   0.   0.  60.    0.0  0.0  0.0
 48  3/ 7 1979.  2 7.8 348.  800.     0. 23.0  3.0 20.0 20.0   60. 26.0  0.1 0.0     0.  56.  0.0   0.   0.  72.  108.0  9.30 0.0
 49  3/ 8 1783.  2 8.0 342.  735.     0. 47.9  1.8 46.0 22.0   45. 27.0  0.1 0.0     0.  53.  0.0   0.   0.  70.    0.0 12.00 0.0
 50  3/ 9 2456.  2 7.5 351.  870.     0. 62.2  9.2 53.0 46.0   48. 23.0  0.1 0.0     0.  47.  0.0   0. 189.  72.    0.0 10.80 0.0
 51  3/10 1937.  2 7.4 380. 1060.     0. 22.2  1.2 21.0  0.0   52. 29.0  0.1 0.0     0.  51.  0.0   0.   0.  72.    0.0  7.90 0.0
 52  3/11 1997.  2 7.6 348.  950.     0.151.3  4.3147.0 36.0   60. 25.0  0.1 0.0     0.  53.  0.0   0.   0.  66.    0.0 10.00 0.0
 53  3/12 2202.  2 7.8 348.  855.     0. 28.7  9.2 19.5  0.0   44. 25.0  0.0 0.0     0.   0.  0.0   0. 196.  60.    0.0  0.0  0.0
 54  3/13 2738.  2 0.0 336. 1020.     0. 38.7  9.2 29.5  0.0    0.  0.0  0.0 0.0     0.   0.  0.0   0. 185.  56.    0.0  0.0  0.0
 55  3/14 2957.  2 8.1 264.  735.     0. 48.7  7.7 40.5 39.0   34. 28.0  0.1 0.0     0.  54.  2.0   0.   0.  68.    0.0 18.30 0.0
 56  3/15 2336.  2 7.5 294. 1060.     0. 46.0  9.5 36.5 46.0   60. 31.0  0.1 0.0     0.  52.  0.0   0.   0.  72.    0.0  7.00 0.0
 57  3/16 2211.  2 7.7 288.  570.     0.  0.0  0.0 28.5 35.0   42. 25.0  0.1 0.0     0.  54.  0.0   0.   0.  74.    0.0  8.90 0.0
 58  3/17 1963.  2 7.8 438.  860.     0. 45.3 10.8 34.5 55.0   68. 31.0  0.1 0.0     0.  58.  0.0   0.   0.  64.    0.0  4.00 0.0
 59  3/18 2438.  2 7.8 306.  950.     0. 44.3  8.8 35.5 43.0   60. 24.0  0.1 0.0     0.  41.  0.0   0.   0.  62.    0.0 17.80 0.0
 60  3/19 2497.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  0.0   0.   0.   0.   44.0  0.0  0.0
 61  3/19 2497.  2 7.9 504. 1085.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  0.0   0. 206.  52.    0.0  0.0  0.0
 62  3/20 2622.  2 7.8 348.  880.     0.  0.0  0.0  0.0  0.0   44. 20.0  0.0 0.0     0.   0.  0.0   0.   0.  62.    0.0  0.0  0.0
 63  3/21 3207.  2 7.7 336.  840.     0. 39.8  5.8 34.0 19.0   44. 76.0  0.0 0.0     0.   0.  0.0   0.   0.  66.    0.0 20.80 0.0
 64  3/22 2390.  2 7.8 354.  820.     0. 49.1  6.1 43.0 20.0   46. 28.0  0.1 0.0     0.  61.  0.0   0.   0.  68.    0.0 15.00 0.0
 65  3/22 2390.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  0.0   0.   0.   0.   31.0  0.0  0.0
 66  3/23 2103.  2 7.8 306.  755.     0. 25.5  4.0 21.5 18.3   40. 27.0  0.0 0.0   275.   0.  2.0   0.   0.  62.    0.0 16.40 0.0
 67  3/24 2129.  2 7.8 264.  730.     0. 34.3  7.3 27.0  0.0   45. 29.0  0.1 0.0   140.  54.  0.0   0.   0.  76.    0.0 17.60 0.0
 68  3/25 1972.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
 69  3/25 1972.  2 8.0 246.  795.     0. 40.6  9.6 31.0 19.0   40. 35.0  0.1 0.0   130.  55.  0.0   0.   0.  68.    0.0  8.60 0.0
 70  3/26 2011.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.   71.0  0.0  0.0
 71  3/26 2011.  2 8.0 384. 1065.     0. 70.0 12.0 58.0  0.0   58. 17.0  0.0 0.0     0.   0.  0.0   0. 207.  64.    0.0  0.0  0.0
 72  3/27 2810.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
 73  3/27 2810.  2 7.7 384. 1125.     0. 55.0 12.0 43.0  0.0   50. 17.0  0.0 0.0     0.   0.  0.0   0. 195.  50.    0.0  0.0  0.0
 74  3/28 2882.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
 75  3/28 2882.  2 8.2 300.  790.     0. 41.0  8.0 33.0 16.0   40. 31.0  0.1 0.0     0.  50.  0.0   0.   0.  68.    0.0 20.80 0.0
 76  3/29 2002.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
 77  3/29 2002.  2 7.7 276.  805.     0. 50.0 11.0 39.0 17.6   60. 29.0  0.1 0.0   146.  54.  0.0   0.   0.  64.    0.0 17.00 0.0
 78  3/30 2039.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
 79  3/30 2039.  2 7.8 318.  880.     0. 33.1  9.1 24.0 23.0   52. 25.0  0.1 0.0     0.  57.  0.0   0.   0.  62.    0.0 13.00 0.0
 80  3/31 2293.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.  112.0  0.0  0.0
 81  3/31 2293.  2 7.7 378.  965.     0. 32.6  9.1 23.5 36.6   40. 26.0  0.1 0.0   130.  49.  0.0   0.   0.  66.    0.0 13.10 0.0
 82  4/ 1 23[illegible].  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
 83  4/ 1 2352.  2 7.7 330.  750.     0. 45.9 10.4 35.5 31.6   56. 23.0  0.1 0.0     0.  55.  0.0   0.   0.  66.    0.0  0.0  0.0
 84  4/ 2 2279.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.   41.0  0.0  0.0
 85  4/ 2 2279.  2 8.0 294.    0.     0. 81.6 12.1 69.5  0.0   56. 61.0  0.0 0.0     0.   0.  0.0   0. 209.  64.    0.0  0.0  0.0
 86  4/ 3 3018.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  0.0   0.   0.   0.    0.0  0.0  0.0
 87  4/ 3 3018.  2 8.7 330.  705.     0. 58.9  8.9 50.0  0.0   56. 54.0  0.0 0.0     0.   0.  0.0   0.   0.  46.    0.0  0.0  0.0
 88  4/ 4 2878.  2 7.6 354.  635.     0. 23.4  4.9 18.5  0.0   50. 32.0  0.1 0.0     0.  50.  0.0   0.   0.  62.    0.0  8.10 0.0
 89  4/ 5 2166.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  0.0   0.   0.   0.    0.0  0.0  0.0
 90  4/ 5 2166.  2 7.9 432.  665.     0. 37.5  8.7 28.8 42.0   55. 26.3  0.1 0.0    71.  54.  0.0   0.   0.  64.    0.0  6.30 0.0
 91  4/ 6 2690.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.   89.0  0.0  0.0
 92  4/ 6 2690.  2 7.7 318.  805.     0. 56.0 11.0 45.0 22.0   40. 30.0  0.1 0.0     0.  54.  0.0   0.   0.  56.    0.0  9.90 0.0
 93  4/ 7 2413.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  4.0   0.   0.   0.    0.0  0.0  0.0
 94  4/ 7 2413.  2 7.8 264.  750.     0. 50.4 10.4 40.0 20.0   40. 28.3  0.1 0.0     0.  46.  0.0   0.   0.  60.    0.0 11.00 0.0
 95  4/ 8 2347.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  4.0   0.   0.   0.    0.0  0.0  0.0
 96  4/ 8 2347.  2 7.8 282.  765.   300. 36.4  6.4 30.0 15.6   40. 29.4  0.1 0.0     0.  49.  0.0   0.   0.  58.    0.0 12.20 0.0
 97  4/ 9 3081.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  1.0   0.   0.   0.   96.0  0.0  0.0
 98  4/ 9 3081.  2 8.1 336.  775.     0. 80.8 12.8 68.0  0.0   40.  0.0  0.0 0.0     0.   0.  0.0   0.   0.  46.    0.0  0.0  0.0
 99  4/10 2455.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
100  4/10 2455.  2 7.8 288. 1100.     0. 45.8  8.8 37.0  0.0   38. 24.7  0.0 0.0     0.   0.  0.0   0.   0.   0.    0.0  0.0  0.0
101  4/11 2698.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
102  4/11 2698.  2 7.7 276.  595.   260. 62.9  8.9 54.0 11.0   34. 28.0  0.2 0.0     0.  54.  0.0   0.   0.  58.    0.0 15.70 0.50
103  4/12 2159.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
104  4/12 2159.  2 7.8 258.  880.   345. 55.1  9.1 46.0 18.0   40. 32.8  0.1 0.0     0.  55.  0.0   0.   0.  60.    0.0  8.50 0.80
105  4/13 2549.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
106  4/13 2549.  2 7.8 270.  730.   305. 51.3  5.3 46.0 13.0    0. 23.0  0.1 0.0     0.  48.  0.0   0.   0.  62.    0.0 20.00 0.0
107  4/14 3030.  1 0.0   0.    0.     0.  0.0  0.0  0.0  0.0    0.  0.0  0.0 0.0     0.   0.  2.0   0.   0.   0.    0.0  0.0  0.0
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108  4/14 3000.  2 0.0   0.    0.    0. 30.7  5.2 25.5  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
109  4/15 3140.  2 0.0   0.    0.    0. 69.2  9.2 60.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
110  4/16 2626.  2 0.0   0.    0.    0. 49.5 10.5 39.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
111  4/17 2590.  2 0.0   0.    0.    0. 56.5  9.5 47.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
112  4/18 2534.  2 0.0   0.    0.    0. 57.0  9.0 48.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
113  4/19 2353.  2 0.0   0.    0.    0. 52.7  7.7 45.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
114  4/20 2301.  2 0.0   0.    0.    0. 49.7  4.2 45.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
115  4/21 2251.  2 0.0   0.    0.    0. 31.1  5.1 26.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
116  4/22 2078.  2 0.0   0.    0.    0. 44.0  9.0 35.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
117  4/23 2594.  2 0.0   0.    0.    0. 36.4  5.9 30.5  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
118  4/24 2771.  2 0.0   0.    0.    0. 58.7  7.7 51.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
119  4/25 2535.  2 0.0   0.    0.    0. 70.6  7.6 63.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
120  4/26 2430.  2 0.0   0.    0.    0. 55.0 11.0 44.0  0.0   0.  0.0  0.0 0.0   0.  0.  0.0  0.  0.  0.   0.0  0.0  0.0
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SAM NUM	DATE	WASTE WATER GPD	SM TP	SETTLEABLE MATTER 1/2HR	1HR	2HRS	TS MG/L	VS MG/L	FS MG/L	TSS MG/L	VSS MG/L	FSS MG/L	TDS MG/L	VDS MG/L	FDS MG/L
1	12/ 2	1566.	1	16.0	16.0	16.0	526.	339.	187.	200.	195.	5.	326.	144.	182.
2	12/ 3	1567.	1	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.
3	12/ 4	1628.	1	0.0	0.0	0.0	818.	586.	232.	340.	336.	4.	478.	250.	228.
4	12/ 9	2230.	1	25.0	28.0	28.0	574.	393.	181.	270.	228.	42.	304.	165.	139.
5	12/10	1957.	1	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.
6	12/11	2164.	1	11.0	13.0	15.0	1049.	865.	184.	221.	221.	0.	828.	644.	184.
7	12/16	1795.	1	26.0	25.0	24.0	718.	490.	228.	315.	315.	0.	403.	175.	228.
8	12/23	2627.	1	12.0	12.0	12.0	600.	310.	290.	246.	217.	29.	354.	93.	261.
9	12/24	2806.	1	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.
10	12/30	2456.	1	11.0	10.0	10.0	816.	468.	348.	200.	172.	28.	616.	296.	320.
11	12/31	2651.	1	26.0	26.0	26.0	1199.	892.	307.	812.	746.	66.	387.	146.	241.
12	1/ 6	1996.	1	19.5	20.0	19.0	877.	553.	324.	205.	186.	19.	672.	367.	305.
13	1/ 7	1998.	1	7.0	6.0	4.0	558.	326.	232.	159.	146.	13.	396.	180.	219.
14	1/ 8	2294.	1	6.5	7.5	7.0	702.	493.	209.	268.	247.	21.	434.	246.	188.
15	1/13	2061.	1	0.1	0.2	0.6	627.	322.	305.	169.	136.	33.	458.	186.	272.
16	1/14	2264.	1	47.0	47.0	47.0	731.	593.	138.	322.	320.	2.	409.	273.	136.
17	1/15	2024.	1	6.5	6.5	6.5	719.	544.	175.	250.	250.	-0.	469.	294.	175.
18	1/20	1869.	1	3.0	3.0	3.8	715.	444.	271.	232.	213.	19.	483.	231.	252.
19	1/21	2046.	1	0.1	0.1	0.0	658.	328.	330.	162.	126.	36.	496.	202.	294.
20	1/22	1883.	1	16.5	17.0	17.0	657.	358.	299.	232.	184.	48.	425.	174.	251.
21	1/27	1856.	1	1.3	1.7	2.0	583.	301.	282.	120.	112.	8.	463.	189.	274.
22	1/28	2337.	1	15.0	15.0	15.0	766.	446.	320.	254.	212.	42.	512.	234.	278.
23	1/29	2494.	1	20.0	21.0	24.0	664.	435.	229.	248.	244.	4.	416.	191.	225.
24	2/ 3	2201.	1	5.5	6.3	7.0	798.	559.	239.	299.	268.	31.	499.	291.	208.
25	2/ 4	2089.	1	13.0	14.0	13.5	754.	491.	263.	278.	245.	33.	476.	426.	230.
26	2/ 5	1880.	1	45.0	45.0	58.0	881.	679.	202.	536.	488.	48.	345.	191.	154.
27	2/10	1884.	1	2.5	4.0	4.0	581.	345.	236.	166.	151.	15.	415.	194.	221.
28	2/11	1981.	1	1.0	1.3	1.5	612.	356.	256.	180.	154.	26.	432.	202.	230.
29	2/16	2004.	2	16.0	17.0	17.0	727.	446.	281.	155.	139.	16.	572.	307.	265.
30	2/17	2143.	2	9.0	8.5	8.5	630.	402.	228.	279.	244.	35.	351.	158.	193.
31	2/18	1869.	2	11.0	10.5	10.0	630.	394.	236.	232.	202.	30.	398.	192.	206.
32	2/19	2044.	2	19.0	19.0	19.0	656.	438.	218.	304.	256.	48.	352.	182.	170.
33	2/20	2526.	2	13.0	12.5	12.5	0.	0.	0.	346.	78.	268.	0.	0.	0.
34	2/21	3311.	2	4.0	4.5	5.0	554.	364.	190.	174.	158.	16.	380.	206.	174.
35	2/22	2039.	2	17.0	18.0	18.0	671.	504.	167.	214.	214.	0.	457.	290.	167.
36	2/23	1950.	2	17.0	18.0	18.0	749.	565.	184.	356.	328.	28.	393.	237.	156.
37	2/24	2110.	2	16.0	15.5	18.0	737.	501.	236.	338.	330.	8.	399.	171.	228.
38	2/25	2304.	2	23.0	23.5	23.0	924.	679.	245.	456.	412.	44.	468.	267.	201.
39	2/26	2099.	2	14.0	14.0	14.0	668.	480.	188.	294.	276.	18.	374.	204.	170.
40	2/27	2385.	2	13.0	13.0	14.0	605.	391.	214.	248.	236.	12.	357.	155.	202.
41	2/28	2994.	2	7.5	7.5	8.0	641.	390.	251.	216.	202.	14.	425.	188.	237.
42	3/ 1	1956.	2	23.0	24.5	23.0	707.	570.	137.	346.	338.	8.	361.	232.	129.
43	3/ 2	1983.	2	25.0	25.0	25.0	718.	499.	219.	456.	420.	36.	262.	79.	183.
44	3/ 3	2083.	2	22.0	22.0	23.0	837.	636.	201.	334.	326.	8.	503.	310.	193.
45	3/ 4	2568.	2	15.0	16.0	16.0	696.	484.	212.	296.	292.	4.	400.	192.	208.
46	3/ 5	2370.	2	14.0	14.5	14.5	917.	562.	355.	280.	278.	2.	637.	284.	353.
47	3/ 6	3152.	2	14.5	15.0	15.0	683.	508.	175.	280.	274.	6.	403.	234.	169.
48	3/ 7	1979.	2	14.0	14.0	0.0	783.	612.	171.	244.	240.	4.	539.	372.	167.
49	3/ 8	1783.	2	15.0	15.0	0.0	656.	452.	204.	298.	298.	0.	358.	154.	204.
50	3/ 9	2486.	2	16.0	17.0	0.0	735.	495.	240.	332.	308.	24.	403.	187.	216.
51	3/10	1937.	2	19.0	19.0	0.0	802.	516.	286.	386.	354.	32.	416.	162.	254.
52	3/11	1997.	2	19.0	19.0	0.0	664.	448.	216.	342.	282.	60.	322.	166.	156.
53	3/12	2202.	2	7.5	8.0	0.0	612.	493.	119.	376.	332.	44.	236.	161.	75.
54	3/13	2738.	2	11.5	12.0	0.0	667.	490.	177.	350.	294.	56.	317.	196.	121.
55	3/14	2957.	2	12.0	12.0	0.0	590.	411.	179.	248.	210.	38.	342.	201.	141.
56	3/15	2336.	2	15.0	15.0	0.0	526.	420.	106.	246.	242.	4.	280.	178.	102.
57	3/16	2211.	2	28.0	29.0	0.0	627.	443.	184.	288.	276.	12.	339.	167.	172.

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 58  3/17 1963.  2  12.5   13.0    0.0     761.    611.  150.  410.  374.    36.  351.  237.  114.
 59  3/18 2438.  2  30.0   30.0    0.0     621.    491.  130.  421.  391.    30.  200.  100.  100.
 60  3/19 2497.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 61  3/19 2497.  2  37.0   38.0   38.0     928.    706.  222.  466.  440.    26.  462.  266.  196.
 62  3/20 2622.  2  20.0   20.0    0.0     732.    536.  196.  346.  334.    12.  386.  202.  184.
 63  3/21 3207.  2  18.0   18.0    0.0     586.    485.  101.  352.  306.    46.  234.  179.   55.
 64  3/22 2390.  2   6.5    7.0    0.0     672.    458.  214.  468.  436.    32.  204.   22.  182.
 65  3/22 2390.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 66  3/23 2103.  2  15.0   15.0    0.0     611.    497.  114.  272.  256.    16.  339.  241.   98.
 67  3/24 2129.  2   8.0    9.0    0.0     605.    471.  134.  229.  217.    12.  376.  254.  122.
 68  3/25 1972.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 69  3/25 1972.  2  15.0   15.0    0.0     777.    583.  194.  362.  352.    10.  415.  231.  184.
 70  3/26 2011.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 71  3/26 2011.  2  17.0   17.0    0.0     687.    557.  130.  376.  370.     6.  311.  187.  124.
 72  3/27 2810.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 73  3/27 2810.  2  11.0   11.0   12.0     629.    503.  126.  350.  348.     2.  279.  155.  124.
 74  3/28 2882.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 75  3/28 2882.  2  11.0   11.0    0.0     593.    471.  122.  324.  310.    14.  269.  161.  108.
 76  3/29 2002.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 77  3/29 2002.  2  10.5    0.0    0.0     660.    462.  198.  266.  235.    31.  394.  227.  167.
 78  3/30 2039.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 79  3/30 2039.  2   9.0    9.0    0.0     695.    528.  167.  334.  322.    12.  361.  206.  155.
 80  3/31 2293.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 81  3/31 2293.  2   7.5    8.0    0.0     543.    357.  186.  348.  292.    56.  195.   65.  130.
 82  4/ 1 2352.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 83  4/ 1 2352.  2  14.0   15.0    0.0     680.    388.  292.  306.  248.    58.  374.  140.  234.
 84  4/ 2 2279.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 85  4/ 2 2279.  2   8.0    9.0    0.0     634.     44.  290.  318.  104.   214.  316.  240.   76.
 86  4/ 3 3018.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 87  4/ 3 3018.  2  10.0   10.0   10.0     769.    440.  329.  384.  295.    88.  385.  144.  241.
 88  4/ 4 2878.  2  13.0   13.0    0.0     636.    354.  282.  318.  162.   156.  318.  192.  126.
 89  4/ 5 2166.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 90  4/ 5 2166.  2  15.0   15.0    0.0     612.    555.   57.  368.  338.    30.  244.  217.   27.
 91  4/ 6 2690.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 92  4/ 6 2690.  2  17.0   17.0    0.0     773.    515.  258.  280.  252.    28.  493.  263.  230.
 93  4/ 7 2413.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 94  4/ 7 2413.  2  13.0   13.0    0.0     671.    480.  191.  302.  268.    34.  369.  212.  157.
 95  4/ 8 2347.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 96  4/ 8 2347.  2  12.0   12.0    0.0     695.    439.  256.  262.  244.    18.  433.  195.  238.
 97  4/ 9 3081.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
 98  4/ 9 3081.  2   8.0    8.5    9.0     636.    354.  282.  272.  222.    50.  364.  132.  232.
 99  4/10 2455.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
100  4/10 2455.  2  11.0   11.5    0.0     678.    336.  342.    0.    0.     0.    0.    0.    0.
101  4/11 2698.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
102  4/11 2698.  2   9.0    9.0    0.0     624.    382.  242.  184.  136.    48.  440.  246.  194.
103  4/12 2159.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
104  4/12 2159.  2  15.0   15.0    0.0     636.    404.  232.  138.  112.    26.  498.  292.  206.
105  4/13 2549.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
106  4/13 2549.  2   8.5    8.5    0.0     581.    340.  241.  166.  140.    26.  415.  200.  215.
107  4/14 3000.  1   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
108  4/14 3000.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
109  4/15 3140.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
110  4/16 2626.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
111  4/17 2590.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
112  4/18 2534.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
113  4/19 2353.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
114  4/20 2301.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
115  4/21 2251.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
116  4/22 2078.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
117  4/23 2594.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
118  4/24 2771.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
119  4/25 2535.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
120  4/26 2430.  2   0.0    0.0    0.0       0.      0.    0.    0.    0.     0.    0.    0.    0.
```

PRESSURE SEWER SYSTEM DEMONSTRATION PROJECT

SAM NUM	DATE	W.WATER GAL/C/D	BOD5 GM/C/D	TCOD GM/C/D	TPO4 GM/C/D	NH3 GM/C/D	ORGN GM/C/D	TOT.N GM/C/D	CL GM/C/D	GREASE GM/C/D	TS GM/C/D	VS GM/C/D	TSS GM/C/D	TDS GM/C/D	S.MAT ML/C/D
29	2/16	27.	37.	115.	4. 3.7	7.	1.1	8.0	6.	0.0	74.	45.	16.	58.	1719.3
30	2/17	29.	36.	78.	5. 4.6	6.	4.1	10.6	6.	0.0	68.	43.	30.	38.	919.3
31	2/18	25.	30.	82.	2. 2.3	5.	1.8	7.3	0.	0.0	59.	37.	22.	38.	990.4
32	2/19	27.	34.	97.	6. 5.9	7.	0.0	7.0	0.	0.0	68.	45.	31.	36.	1959.9
33	2/20	34.	39.	115.	7. 7.4	8.	8.4	16.6	0.	0.0	0.	0.	44.	0.	1593.5
34	2/21	44.	43.	123.	13. 13.4	9.	1.2	10.5	8.	0.0	93.	61.	29.	63.	751.9
35	2/22	27.	22.	75.	4. 4.4	6.	3.4	9.2	6.	0.0	69.	52.	22.	47.	1852.2
36	2/23	26.	43.	89.	4. 3.6	4.	3.3	7.3	6.	0.0	74.	56.	35.	39.	1771.4
37	2/24	28.	46.	96.	5. 5.4	5.	3.4	8.7	5.	0.0	78.	53.	36.	42.	1650.5
38	2/25	31.	43.	95.	5. 5.3	7.	3.7	10.7	7.	0.0	107.	79.	53.	54.	2732.5
39	2/26	28.	35.	85.	0. –	6.	1.3	7.2	0.	0.0	71.	51.	31.	40.	1483.0
40	2/27	32.	42.	93.	0. –	7.	2.0	9.0	0.	0.0	73.	47.	30.	43.	1565.4
41	2/28	40.	41.	101.	10. 10.3	6.	4.1	10.4	7.	21.2	97.	59.	33.	64.	1133.2
42	3/ 1	26.	34.	91.	4. 4.1	6.	2.6	8.9	5.	0.0	70.	56.	34.	36.	2418.5
43	3/ 2	26.	35.	92.	3. 3.4	6.	2.5	8.5	5.	0.0	72.	50.	46.	26.	2501.9
44	3/ 3	28.	34.	152.	5. 5.0	6.	3.5	9.8	6.	0.0	88.	67.	35.	53.	2312.7
45	3/ 4	34.	44.	95.	4. 4.3	6.	4.1	10.4	7.	0.0	90.	63.	38.	52.	2073.6
46	3/ 5	32.	44.	102.	3. 2.9	7.	2.0	8.7	0.	0.0	110.	67.	33.	76.	1734.3
47	3/ 6	42.	55.	174.	0.	9.	2.1	11.0	0.	0.0	109.	81.	45.	64.	2386.1
48	3/ 7	26.	35.	80.	2. 2.3	6.	2.6	8.6	6.	10.8	78.	61.	24.	54.	1398.2
49	3/ 8	24.	31.	66.	4. 4.5	4.	2.4	6.5	5.	0.0	59.	41.	27.	32.	1349.7
50	3/ 9	33.	44.	109.	8. 7.8	6.	2.9	8.9	6.	0.0	92.	62.	42.	51.	2132.8
51	3/10	26.	35.	104.	2. 2.2	5.	2.8	7.9	5.	0.0	78.	50.	38.	41.	1857.3
52	3/11	27.	35.	96.	15. 15.2	6.	2.5	8.6	5.	0.0	67.	45.	34.	32.	1914.9
53	3/12	29.	39.	95.	3. 3.2	5.	2.8	7.7	0.	0.0	68.	55.	42.	26.	889.0
54	3/13	37.	46.	141.	5. 5.3	0.	0.0	0.0	0.	0.0	92.	68.	48.	44.	1658.1
55	3/14	39.	39.	110.	7. 7.2	5.	4.2	9.3	8.	0.0	88.	61.	37.	51.	1790.8
56	3/15	31.	35.	125.	5. 5.4	7.	3.7	10.7	6.	0.0	62.	50.	29.	33.	1768.4
57	3/16	29.	32.	64.	0. –	5.	2.8	7.5	6.	0.0	70.	49.	32.	38.	3235.9
58	3/17	26.	43.	85.	4. 4.5	7.	3.1	9.8	6.	0.0	75.	61.	41.	35.	1287.9
59	3/18	33.	38.	117.	5. 5.5	7.	3.0	10.3	5.	0.0	76.	60.	52.	25.	3691.1
61	3/19	33.	64.	134.	0. –	0.	0.0	0.0	0.	0.0	117.	89.	59.	58.	4788.6
62	3/20	35.	46.	116.	0. –	6.	2.6	8.5	0.	0.0	97.	71.	46.	51.	2646.5
63	3/21	43.	54.	136.	6. 6.4	7.	12.3	19.4	0.	0.0	95.	78.	57.	38.	2913.2
64	3/22	32.	43.	99.	6. 5.9	6.	3.4	8.9	7.	0.0	81.	55.	56.	25.	844.3
66	3/23	28.	32.	80.	3. 2.7	4.	2.9	7.1	0.	0.0	65.	53.	29.	36.	1592.0
67	3/24	28.	28.	78.	4. 3.7	5.	3.1	8.0	6.	0.0	65.	51.	25.	40.	967.0
69	3/25	26.	24.	79.	4. 4.0	4.	3.5	7.5	5.	0.0	77.	58.	36.	41.	1492.8
71	3/26	27.	39.	108.	7. 7.1	6.	1.7	7.6	0.	0.0	70.	57.	38.	32.	1725.3
73	3/27	37.	54.	160.	8. 7.8	7.	2.4	9.5	0.	0.0	89.	71.	50.	40.	1559.9
75	3/28	38.	44.	115.	6. 6.0	6.	4.5	10.3	7.	0.0	86.	69.	47.	39.	1599.9
77	3/29	27.	28.	81.	5. 5.1	6.	2.9	9.0	5.	0.0	67.	47.	27.	40.	0.0
79	3/30	27.	33.	91.	3. 3.4	5.	2.6	7.9	6.	0.0	72.	54.	34.	37.	926.1
81	3/31	31.	44.	112.	4. 3.8	5.	3.0	7.6	6.	0.0	63.	41.	40.	23.	925.8
83	4/ 1	31.	39.	89.	5. 5.5	7.	2.7	9.4	7.	0.0	81.	46.	36.	44.	1780.5
85	4/ 2	30.	34.	0.	9. 9.4	6.	7.0	13.5	0.	0.0	73.	40.	37.	36.	1035.1
87	4/ 3	40.	50.	107.	9. 9.0	9.	8.2	16.8	0.	0.0	117.	67.	58.	59.	1523.1
88	4/ 4	38.	51.	92.	3. 3.4	7.	4.6	11.9	7.	0.0	92.	51.	46.	46.	1888.2
90	4/ 5	29.	47.	73.	4. 4.1	6.	2.9	8.9	6.	0.0	67.	61.	40.	27.	1639.7
92	4/ 6	36.	43.	109.	8. 7.6	5.	4.1	9.5	7.	0.0	105.	70.	38.	67.	2307.8
94	4/ 7	32.	32.	91.	6. 6.1	5.	3.4	8.3	6.	0.0	82.	58.	37.	45.	1583.1
96	4/ 8	31.	33.	84.	4. 4.5	5.	3.5	8.2	6.	0.0	82.	52.	31.	51.	1421.3
98	4/ 9	41.	52.	121.	13. 12.6	6.	0.0	6.7	0.	0.0	99.	55.	42.	57.	1321.6
100	4/10	33.	36.	136.	6. 5.7	5.	3.1	7.8	0.	0.0	84.	42.	0.	0.	1424.8
102	4/11	36.	38.	81.	9. 8.6	5.	3.8	8.4	7.	0.0	85.	52.	25.	60.	1225.4
104	4/12	29.	28.	96.	6. 6.0	4.	3.6	7.9	6.	0.0	69.	44.	15.	54.	1634.4

106	4/13	34.	35.	94.	7. 6.6	0.	3.0	3.0	6.	0.0	75.	44.	21.	53.	1093.4
108	4/14	40.	0.	0.	5. 4.6	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
109	4/15	42.	0.	0.	11. 11.0	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
110	4/16	35.	0.	0.	7. 6.6	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
111	4/17	35.	0.	0.	7. 7.4	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
112	4/18	34.	0.	0.	7. 7.3	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
113	4/19	31.	0.	0.	6. 6.3	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
114	4/20	31.	0.	0.	6. 5.8	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
115	4/21	30.	0.	0.	4. 3.6	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
116	4/22	28.	0.	0.	5. 4.6	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
117	4/23	35.	0.	0.	5. 4.8	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
118	4/24	37.	0.	0.	8. 8.2	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
119	4/25	34.	0.	0.	9. 9.0	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0
120	4/26	32.	0.	0.	7. 6.7	0.	0.0	0.0	0.	0.0	0.	0.	0.	0.	0.0

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